# NATURE

Vol. 142 SATURDAY, AUGUST 6, 1938 No. 3588

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD., ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831 Telegraphic Address: Phusis, Lesquare, London
The annual subscription rates are: £2 12 0 British Isles, £2 17 0 Foreign, payable in advance

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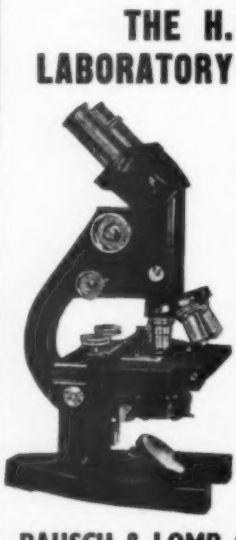

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Vol. 142 SATURDAY, AUGUST 6, 1938 No. 3588

# Science and a World Foundation

ON several occasions, attention has been directed in NATURE to the important work undertaken by the Committee on Science and its Social Relations, set up by the International Council of Scientific Unions, and views have been expressed upon the desirability of establishing an organization for the study of the social relations of science (see Supplement to NATURE of April 23, 1938). Briefly, the function of the former is to survey the scientific work done in certain fields, with a view to the issue at intervals of a report, with bibliography, concerning the influence of science on human society and the reaction of scientific study to the social environment; while the latter body would seek to advance knowledge on these matters by research and by the discussion and publication of papers, as well as in other ways. It is generally agreed that both bodies should be careful to avoid propaganda and endeavour to be strictly impartial in the exercise of their judgment. Scientific workers are rightly jealous of the high reputation they have earned for their purely objective approach to the questions they study, and it would be lamentable if any ill-considered action resulted in the devaluation of so precious a heritage.

On the other hand, men of science do not spend the whole of their lives in their laboratories. They have at least as great a concern as others in the outcome of their labours, and it should be possible to satisfy these wider interests and aspirations without prejudice to the character or standard of their work. In considering the fit application of the results of their researches, especially in their bearing upon the relations between different countries, a general guiding principle has been enunciated to which the great majority of scientific workers would readily assent: that *the welfare of humanity and the interest of the whole community of nations should be placed before the narrower interests of any individual nation.* Such a principle could scarcely be held to conflict with that objectivity of outlook which men of science endeavour to maintain. On the contrary, to reach this ideal calls for a mental poise and freedom from bias which anyone might be proud to achieve. It is certainly true to say that, whatever may have been the intentions of individuals, whether as private persons or as the representatives of their countries, its attainment has not proved easy in the past. Frequently, failure has resulted from putting a lower in front of a higher loyalty; the protagonists of different Governments—and it may be doubted if any have been invariably blameless in this respect—when an important crisis has arisen, have adopted too parochial and partisan a conception of their responsibilities.

This fact is brought out convincingly by Senor de Madariaga in "The World's Design", a penetrating analysis of post-War international politics. The author writes with unrivalled authority. For more than six years he was head of the Disarmament Section of the League of Nations Secretariat, and later for about the same length of time he was his country's delegate to the Council, the Assembly, and the Disarmament Conference of the League. The conclusion to which he came as the result of this experience is, therefore, highly significant. He believes that the rivalry between nations will never be resolved until we succeed in convincing those who are in control of affairs that, whether we be Britons or Germans, Frenchmen or Italians, Americans or Japanese, we are all members of one world body; that consequently "there should be no schism in the body;

but that the members should have the same care one for another. . . . The eye cannot say unto the hand, I have no need of thee. . . . And whether one member suffer, all the members suffer with it; or one member be honoured, all the members rejoice with it". This surely must be the basis of the appeal made even to those who lay particular stress on the virtues of some nations and races at the expense of others; indeed, the necessity to win their approval for that doctrine is the more urgent since our own good is so intimately bound up with theirs. If we ourselves are driven, for the sake of petty retaliation or from a mistaken sense of what constitutes security, to adopt a narrow self-centred course of action, we shall merely prolong and embitter the misunderstanding between nations.

One aspect of an alternative and constructive policy, that relating to trade, is rightly stressed in a report recently prepared by an expert committee of economists, bankers, business men and others for a widely representative Conference on Peace and Economic Policies held at Washington in the spring of this year. As it illustrates the trend of an important section of American opinion, an extract from it is worth quoting. Urging their Government to make every effort to promote a greater interchange of goods and services between the nations generally, they say: "Trade can be called the world's most potent instrument of peaceful change. Abundant trade between nations lessens the economic importance of boundaries; removes most of the causes of complaint about lack of access to raw materials that can justly be made by any State on grounds of peace-time needs; eases tensions over colonies in so far as those tensions are really rooted in economic grievances and are not simple matters of pride and prestige; lessons the likelihood of exploitation of consumers by foreign or domestic monopolies; makes debt payments easier for debtors and more probable for creditors; facilitates thousands of everyday adjustments that in turn prevent the development of social conflict within nations and between nations." All this is sound sense, but how is the objective to be achieved? Madariaga's proposal is that, instead of working within national environments which are inevitably influenced by national interests and outlooks, we should start from the other end, from the conception of world unity, and work back to differences in national policy, using this central conception to throw new light on the problem in hand.

What part then can men of science play in hastening the desired evolution towards this world outlook in international affairs? In the first place, they can play an extremely important part by contributing to an expert and impartial survey, qualitative as well as quantitative, of the world's resources in land and people, raw materials and manufactured articles, buildings and technical equipment. It is essential that we should begin by ascertaining these fundamental facts, if we are to seek to satisfy the basic needs of all nations and to make adequate provision for a rising standard of life, notably in the more backward countries. Already, much valuable research has been carried out along these lines by responsible bodies, such as the League of Nations, the International Labour Office, the Royal Institute of International Affairs, and the Institute of Pacific Relations. But it is necessary to go further. If such inquiries are to become really effective, they must be co-ordinated, and public attention must be focused upon the conclusions reached.

One example may be given to illustrate their vital importance and their possible repercussions upon events in the international sphere. It is well known to men of science, but not to the general public, that nickel is an essential component of all steels used for armaments as well as for other purposes, and that practically the whole of the world's supply comes from a relatively small area in Canada. Putting these two facts together, can we not draw the inference that it should be possible to limit the manufacture of armaments by controlling the distribution of nickel? Surely here, actually in the hands of the British Commonwealth of Nations, is a powerful lever which has not been sufficiently explored for regulating international relations and securing peace; and unless world peace is assured, all hope of human progress and prosperity is dimmed. What is true of nickel is true, in greater or less degree, of other important minerals and foods. In fact, the United States and the U.S.S.R. are the only two great powers which do not customarily import large quantities of essential raw materials, and even they lack some commodities indispensable to normal economic life.

It is for reasons such as these that the formation of a Scientific Section of Madariaga's World Foundation (see NATURE, June 18, p. 1074) would be welcomed by many leading men of science. A group of this character would be able to guide

research into problems of world import and be a fitting medium for making the results public. In this way scientific workers would have what they at present lack, opportunity for making the full weight of their collective opinion, based upon an authoritative and impartial study of the facts, felt in the councils of the nations. A lead would thus be given which would no doubt be followed by other groups, drawn together, like men of science, on a functional basis. It has been suggested, for example, that heads of universities and colleges might also combine to form a section of the World Foundation; and possibly bankers and economists might form another. Such a formation would have the advantage that the members of each section would know and could establish contact with distinguished workers in the same field in other countries. Associated nuclei of thinking men and women would then be found throughout the world, all of whom would be contributing in their several ways to the education of public opinion directed to the same great end—the transformation of a League composed of a few nations into an effective World State.

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# "La critique est la vie de la science"

The Grammar of Science

By Karl Pearson. (Everyman's Library, No. 939.) Pp. xxv+359. (London: J. M. Dent and Sons, Ltd., 1937.) 2*s*. net.

THE previous editions of the "Grammar of Science" were published in 1892, 1900 and 1911. They have been exhausted for a long time, but, whenever the question of a new issue was mentioned, Karl Pearson used to answer that the old text was out of date and that he was too busy with other work to undertake the necessary revision. It was never undertaken, and the present posthumous edition reproduces the chapters of the original one of 1892, using, however, their text as it was prepared for the edition of 1900.

We must agree with Karl Pearson that some points in the "Grammar of Science" are out of date now. The progress in all branches of science during the forty-five years since its first appearance has been enormous, and many theories which then appeared as new are now obsolete or nearly so. Nevertheless, the book is worth preserving. It sets out undying principles, and any book that does that must live. The advance of science beyond where it had got when the book was written will appear far less important a hundred years hence than it does to-day, for the changes of the past forty years will have been changed. Looking back now, we see how the state of knowledge—or "belief"—in 1770 is little different from what it became in 1820; though in 1820 the difference seemed very important.

But the "Grammar" does not represent any sort of text-book designed to provide information as to the actual state of science. It is just the *grammar* of science, or perhaps, of thought, and just here rests its permanent importance. The purpose of the "Grammar" is indicated in the motto which is used as the title of the present article and is explained in the preface, where Pearson says, "There are periods in the growth of science when it is well to turn attention from its imposing superstructure and to carefully examine its foundations. The present book is primarily intended as a criticism of the fundamental concepts of modern science. . . ."

The contents of the book are in harmony with the above announcement. Reviewing the *principia*, the fundamental conceptions of science which were at the time either generally accepted or being introduced, Karl Pearson analysed carefully their real meaning. He showed the reader how to distinguish between what is known and what is only believed in, what is a dogma and what is a generalized formula invented to put into a systematic order a number of sequences of sense-impressions. Using simple examples, he explained that 'exact sciences' deal only with abstract conceptions which may or may not correspond to realities without losing their importance and usefulness. For example, in physics and chemistry, we speak of electrons as of realities and probably there are realities corresponding to the concept of the electrons; however, even if there were none, nobody would deny the utility and the importance of the concept. But between the world of concepts and the 'real' world of sense-impressions, there is a chasm which can be only bridged by a more or less accurate correspondence. Geometry as a mathematical science deals with conceptions of planes, lines, etc. It is not concerned with dots which we may make on a sheet of paper or with the poles erected by surveyors. Still there is a correspondence—not an

identity—between the two, and such things as the configuration of dots and poles are the origin of geometry and also the practical part of its ultimate aim.

In 1892, there was much confusion about these and similar points, and as Pearson put it, it was "difficult to imagine anything more hopelessly illogical than the statements with regard to force and matter current in elementary textbooks". Later on, in 1900, Pearson recorded a considerable improvement and expressed the hope that "the science of the future, while agnostic as to the supersensuous, will replace *knowledge* by *belief* in the perceptual sphere and reserve the term *knowledge* for the conceptual sphere—the region of their own concepts and ideas—of ether, atom, organic corpuscle and vital force—of physical and plasmic mechanics".

There is no doubt that Karl Pearson's hope is by now fulfilled in many quarters. For example, the opinion that geometry is concerned with 'discovering' the properties of a 'really existing space' would probably be generally considered to-day as very naïve. Yet, the clarification of ideas about science has not affected all its branches to the same extent. Paradoxically enough, the very branch which was recently developed largely under the direct influence and inspiration of Karl Pearson himself, is not in a very satisfactory situation. I mean, of course, mathematical statistics. Before Karl Pearson, it could scarcely be considered as an independent science. Since his writings, however, a great number of authors all over the world have been attracted by the subject, and to-day statistical literature concerned both with the theory and with its applications is enormous.

Repeating the usual phases of development of all mathematical sciences, mathematical statistics started with solving various particular problems having in view some immediate practical application. One can easily understand the enthusiasm of the authors discovering more and yet more distant fields where their results could be usefully applied. But this enthusiasm and the rapid, and in many respects brilliant, development of mathematical statistics could not escape certain dangers. The rapidity of the development in width, so to speak, was associated with a much slower process in depth. When reaching some result promising an important practical application, the authors did not care to make much effort to put it into precise terms, distinguishing clearly the conceptual and perceptual spheres of thought, or to give satisfactory mathematical proofs.

At the early stages, such an attitude was understandable, forgivable and probably even useful. But it has established bad habits. It is only in exceptional cases that present-day authors think of distinguishing between what they have to say about observable facts and the conclusions deducible from postulates. The two spheres are usually mixed.

It would be easy to illustrate this, but any example of importance and its subsequent discussion would take more space than an article like the present can afford to give. It is therefore hoped to illustrate the problem in more detail elsewhere. But to indicate what I have in mind, I may quote a minor misunderstanding contained in a short passage from an important article published recently. Unimportant as the example is, it provides a remarkable illustration of the confusion of the perceptual and the conceptual spheres of thought. "The normal or Gaussian law of error rests partly on a particular hypothesis about the nature of error, that the error of any individual observation is the resultant of a large number of comparable and independent components; and partly on comparison with frequencies in actual series of observations. Both arguments are defective". If the "Gaussian law rests" on some hypothesis or other, then these words are meant to denote merely some mathematical theorem. But then any comparison with the results of actual experiments would be irrelevant. On the other hand, if the "law" is meant as a description of some observational facts, then it could not "rest" on a hypothesis.

Even when authors write on what purports to be the mathematical theory of statistics, they do not aim at the accuracy of proof and presentation to which we have been accustomed in other branches of mathematics for many generations. Lack of clear and systematically arranged definitions (for example, some authors prefer to arrange them in alphabetical order !) makes it difficult for one statistician to understand another and, their *knowledge* being mixed with *beliefs*, they frequently engage in acute and fruitless disputes. Unusual passages to the limit, integration term by term of divergent series, hidden and inadmissible differentiations under the sign of the integral are very common, and the theorems, purported to be 'rigorously demonstrated' prove to be 'inapplicable' in this, that and some other particular case.

To put it shortly, it seems to me that with mathematical statistics, we are to-day in a period "when it is well to turn attention from its imposing superstructure and to carefully examine its foundations". The whole body of statistical knowledge should be revised and criticized, including, of course, the work of Karl Pearson himself. That statistical literature of the present day contains a considerable amount of criticism in general and of Karl Pearson in particular is true. But this criticism

is of a specific kind. What is wanted is not attacks on particular authors, but a dispassionate and constructive review of the whole body of our knowledge of mathematical statistics. Owing to the work of the French School and of such writers as A. Kolmogoroff and H. Cramér, the theory of probability is already on a proper level. Similarly, we have good expositions of the elements of statistical theory, such as books by W. P. Elderton and by G. Udny Yule and M. G. Kendall, covering roughly what was thoroughly worked out either by Karl Pearson himself or by what may be called the first team of workers inspired by him. Now is the time to set to work so that we may put in order what has been done of recent years: to apply, in fact, to mathematical statistics the principles that Karl Pearson applied in the "Grammar of Science" to science generally. By reminding us of these principles, the new edition of the "Grammar" should do much to create among the theoretical statisticians the necessary critical spirit.

J. NEYMAN.

# Structure, Properties and Uses of Timber

(1) Timber:
its Structure and Properties. By H. E. Desch. Pp. xxi + 169 + 27 plates. (London: Macmillan and Co., Ltd., 1938.) 12*s*. 6*d*. net.

(2) Timber Drying and the Behaviour of Seasoned Timber in Use
By R. G. Bateson. Pp. xiv + 138 + 7 plates. (London: Crosby Lockwood and Son, Ltd., 1938.) 10*s*. 6*d*. net.

(3) Wood Preservation
By George M. Hunt and Prof. George A. Garratt. Pp. ix + 457. (New York and London: McGraw-Hill Book Co., Inc., 1938.) 30*s*.

(4) Timber Products and Industries:
the Harvesting, Conversion and Marketing of Materials other than Lumber, including the Principal Derivatives and Extractives. By Prof. Nelson Courtlandt Brown. Pp. xviii + 316. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 17*s*. 6*d*. net.

THERE have recently appeared four manuals, two published in Great Britain and the other two in the United States, which deal with wood and its technical properties, which with the exception of timber mechanics, cover most of the available knowledge on the subject.

(1) Desch has attempted to assemble all available information, and in so doing has rendered a service, as the literature available on the subject is at present scattered through many reports, bulletins, records and pamphlets, issued by research organizations and individuals.

The author has divided his subject into four parts, dealing first with the structure of timber, followed by a short treatise on its gross features. Part 3 discusses the properties of wood, basing the information largely on investigations carried out in more recent years, both in Great Britain and in the United States. Seasoning of timber is dealt with under the heading "Considerations influencing the Utilization of Timber"; the subject-matter is good, and it might more suitably have found place in Part 3. The book runs for 169 pages, with ninety good illustrations. The work is the first of its kind and should be useful.

(2) Bateson's book is a complete treatise on the subject, and is a welcome addition to the literature on timber technology, especially as it incorporates all the most recent results of research. The book opens with a discussion on the necessity of seasoning timber before use, followed by a detailed description of what takes place as the wood loses its moisture, which discussions lead on to methods of air- and kiln-seasoning.

It is noticeable the practical way in which the author has approached his subject, always keeping in mind the many difficulties the operator may encounter, especially in kiln-seasoning. As an example, may be cited the inclusion of drying schedules to assist those dealing with the more common timbers in use in Great Britain. The descriptions of various types of drying kilns is fully gone into, as also control instruments. The chapter dealing with prevention of splitting and warping is instructive, and it is shown how these defects may be greatly minimized by a little forethought and expense. The book ends with an engaging chapter on the future of seasoning timber in Great Britain, in which the author is perhaps over-sanguine as to extension of kiln-seasoning. The work is well illustrated and contains 131 pages of letterpress.

(3) "Wood Preservation", by Hunt and Garratt, is a work of mark, as might be expected from two authors with such wide experience. As a text-book it should admirably fulfil its object, which is stated to be for the use of forest and engineering schools and for those employed in treating and using processed timber. All factors governing antiseptic

treatment of timber are dealt with, primarily referring to the industry in the United States, while from the text it is very apparent that much of the data given and facts recorded are from observations made and results obtained in the laboratory and field by the authors themselves.

The problems involved in wood preservation are discussed and two chapters are devoted to deterioration of wood, which is estimated to amount in the United States to fifty million pounds sterling annually. Both in Great Britain, as in America and the Continent, many hundreds of wood preservatives have been tried in the last eighty years, but coal-tar creosote and its derivatives may be said still to hold the day, though latterly in the United States and in India creosote has been mixed with petroleum oils, primarily with the object of reducing costs. Much stress is laid by the authors on seasoning timber before treatment—and rightly so.

The processes of treating timber are described, but nothing very strikingly new is recorded. Probably the most original part of the work is the chapter dealing with the economic aspect of preserving timber. The end is a treatise on fire-retarding treatment of wood, in which it is stated that the industry has not developed rapidly in the States. The book is of 457 pages and is illustrated by clear photographs and figures.

(4) In "Timber Products and Industries" by N. C. Brown, it is stated that the object is twofold; to give in detail the many uses and processes of manufacture of wood in the United States, and throughout to stress ways and means of reducing waste. The author argues—and rightly so—that by grouping several wood-working industries in the vicinity of large forests, intense utilization of the crop may be ensured.

The book is divided into seven parts, commencing with constructional material, and going on to chemically derived products—an interesting chapter. In describing in great detail the naval stores industry, which is the largest in the world and located in the Southern States, the author continually uses the term gum for resin, which would appear to be the common term used in the United States, though curiously incorrect. In connexion with this industry, it would appear that by far the greatest quantity of resin is distilled in direct-fired stills, whereas in France and in India the process of distillation is carried out under vacuum in steam stills, no doubt due to the fact that the resins contain higher boiling point oils. The chapters dealing with mechanically reduced products and wood fuel, charcoal, briquetting and wood gas are of interest and worth study.

The work, covering 316 pages, is extensively illustrated, though the plates are in some cases neither clear nor sharp. R. S. P.

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# Current Physics

## The Physical Society

Reports on Progress in Physics, Vol. 4. General Editor: Allan Ferguson. Pp. vi + 389. (London: The Physical Society, 1938.) 20*s*. net.

A RAPIDLY changing science such as physics sets a difficult task to those attempting classifications or the preparation of annual reports. Favoured classifications may be almost as numerous as the classifiers. In any one year the amount of new results published in each of the main divisions of physics varies considerably. Most of the results fit into one of two classes.

In the larger class, a physical constant or group of constants which has already been determined for $n$ substances is determined for the $n+1$th substance. These research papers are easy to classify, to abstract and to tabulate. It may well be doubted whether an ordered story of this kind of research helps either the research worker or the scholar. The data are more readily accessible if presented in tables or in such a scheme as the card index system of the Science Museum library. What is new in type in this class of researches is usually a matter rather of technique than of result.

In the second type of research, new properties of substances, already examined by older methods, are studied by placing the substance in a new environment where it is subjected to new physical conditions. These researches are much fewer and are far more difficult to abstract, to classify or to deal with in reports. There can be little doubt, however, that all would wish to see them in annual reports both for their intrinsic interest and for the relevance of their results to work in progress.

In this fourth annual volume of the Physical Society's reports the editor, Prof. Allan Ferguson, explains in a preface the aims and objects of the reports. The original suggestion was that each annual report would cover the main branches of physics and that one or two articles dealing with prior developments in some special subject would

le included. The policy of the Society is not, however, fixed and immutable, and the present volume shows a welcome increase in the number and extent of these special articles, dealing with subjects as widely varying as the measurement of time, supersonics in relation to molecular constitution, refrigeration, the application of Fourier series methods to molecular structures and the diamagnetic and paramagnetic anisotropy of crystals.

There is in most of the sections a welcome unbending by the writers of even the most highly technical articles, in that the standard terms of their subject are carefully explained. For example, on pp. 339–40, Dr. J. M. Robertson explains the term "structure factor" before dealing with the most complex crystal structure determinations.

Biological factors are gradually receiving recognition and study in physics, chiefly in applied physics. They are unavoidable in musical acoustics, and Dr. E. G. Richardson in his general article on sound includes a section called conventionally "Subjective Aspects" containing reference to work on aural flicker. In refrigeration, the biological properties of food to be stored are briefly discussed by Dr. Ezer Griffiths. Mr. W. H. Ward deals with electrical oscillation and biological materials.

In all these subjects the relevance of biological properties of the material studied is readily apparent. It is less apparent in general physics, where its recognition might help clarity. For example, the 'observer' is referred to in two quite different articles. In a fascinating article on the measurement of time, the Astronomer Royal has much to tell of the use of the eye and ear and of observations made by different observers. Although he starts in astronomical style by stating that "The measurement of time depends fundamentally upon the rotation of the earth on its axis", it is clear from the subsequent discussion that he might equally well have started in biological style by declaring that "The measurement of time, like every other measurement, depends fundamentally upon human judgment of coincidence". The research worker is usually satisfied to take his time from standard time signals, clocks and tuning forks. Dr. Spencer Jones here gives a clear and concise account of what has to be done by the astronomer to give these trustworthy standards. The essential part played by the human observer is quite definitely stated.

The second article referring to the 'observer' seems to leave the reader in some doubt as to the nature of the observer. In his article on the beginnings of the new quantum theory, Dr. H. T. Flint explains that the behaviour of particles may be studied by means of the wave equation. Reference is then made to observers. "When observers have made experiments and eliminated their own vagaries and those of their apparatus, they will come to the conclusion that in particular circumstances they have been able to locate a particle. . . ." By using coincidence observation, experimental physicists can locate tiny drops of oil in the Millikan experiment, or of water in a Wilson cloud chamber or tiny fragments of sulphur in a Brownian motion experiment. But none of these tiny objects is a 'particle'. They each have dimensions. On p. 166 it is stated that "If we wish to locate a particle by any optical method as accurately as we can, we illuminate it with very short wave length and look at or photograph the object, using a microscope to help us". Apart from the reference to a 'particle', this statement suggests laboratory operations carried out by human observers.

The Astronomer Royal leaves us in no doubt that he is writing about human observers with eyes, ears, hands and even initials (p. 6). Dr. Flint's exposition leaves the relationship, if any, of his observers to the type discussed by the Astronomer Royal in considerable doubt.

In general character the volume is similar to the *Reviews of Modern Physics* but with a wider scope than any one volume of the American publication. The most striking omission is an index. A classified annotated analysis of the year's physics books, compiled from the monthly lists given in NATURE, might be very helpful to those physicists who cannot use the larger libraries.

At the end of his preface, Prof. Allan Ferguson for once seems to give up a little of his broad-mindedness in order to warn reviewers against discussing co-ordination in such work as the preparation of annual reports. "Nor is it a matter for grave concern if an article on recent advances in nuclear physics appears simultaneously with an article having the same title and published under the auspices of, say, the Zetetic Society." Must scientific workers, then, like politicians, wait until a matter is one for grave concern before doing anything about it? If so, they may at least 'deeply deplore' the lack of co-ordination. "In any case the present reports are published primarily in the interests of the Fellows of the Society". Yet co-ordination of the essential, but non-creative, part of scientific work is surely in the interests of the members of any society. The jovial personality of the present editor could secure co-operative effort if it were humanly possible. We may hope, therefore, that in a future preface he will tell something of the avenues explored and the stones turned in the effort to secure co-operation.

W. H. GEORGE.

### Cryptogamic Botany

Vol. 1: Algæ and Fungi. By Gilbert M. Smith. Pp. viii+545. 24*s*. Vol. 2: Bryophytes and Pteridophytes. By Gilbert M. Smith. Pp. vii+380. 18*s*. (McGraw-Hill Publications in the Botanical Sciences.) (New York and London: McGraw-Hill Book Co., Inc., 1938.)

THESE two volumes together form a good general review of the Cryptogams in which representative series in each of the major groups are described in detail. Though most of the types chosen are those found in the United States, the majority are so very widespread that students who adopt these books for their reading in cyptogamic morphology need not necessarily be confined to the United States. Thus, the work should be welcomed by British students, since, though the major groups of Cryptogams are well reviewed in separate British text-books, there are few satisfactory single works which cover all representative Cryptogams.

Vol. 1 opens with a discussion of the classification of spore-producing plants. The author gives cogent reasons for not recognizing the Thallophyta as a division of the plant Kingdom, but prefers to split the Algæ into several distinct divisions. He also gives reasons for considering the Fungi as having evolved from Protozoa rather than Algæ, and therefore keeps them apart. Following this discussion are descriptions of various types of Algæ, Fungi, Fungi-Imperfecti and Lichens.

Vol. 2 considers the Bryophyta and Pteridophyta. The Bryophyta are considered in the evolutionary series—Hepaticæ, Anthocerotæ and Musci; thus the author follows Howe's suggestion that the Anthocerotæ (consisting of a single order—Anthocerotales) be placed in a special class co-ordinate with the other two. The Pteridophyta are divided into the more generally accepted classes—Psilophytinæ, Lycopodinæ, Equisetinæ and Filicinæ.

These two volumes can be warmly recommended to students of cryptogamic botany. In themselves there is enough material for students reading for a general degree, whereas for the benefit of honours degree students ard research workers there are about two thousand references.

### The Petrology of the Sedimentary Rocks

By Dr. F. H. Hatch and Dr. R. H. Rastall. Third edition, revised by Maurice Black. (Text-Book of Petrology, Vol. 2.) Pp. iv+383. (London: George Allen and Unwin, Ltd., 1938.) 15*s*. net.

MUCH research on problems connected with the sedimentary rocks has been carried out since the publication of the last edition of Hatch and Rastall's text-book, in 1923. The appearance of a revised edition is therefore timely. The author and subject bibliographies with which the latest edition is provided reveal the extent of the literature on sediments, and it is noteworthy that a very considerable proportion of the papers cited have been issued during the last fifteen years. The task of revision, which has been carried out by Mr. M. Black, must therefore have been no light one. Actually a great deal of the text has been re-written, and the general arrangement of the subject-matter has been modified. Apart from the incorporation of new material, an important change is the omission of the chapters on metamorphism. These, it is claimed, would now be superfluous, owing to the publication recently of Dr. A. Harkers' book "Metamorphism". On the other hand, Mr. T. Crook's useful appendix on the minerals met with in the loose detrital sediments, which was excluded from the second edition, has been re-introduced in modified form.

Mr. Black has carried out his task very thoroughly, and few omissions of any importance were noted. It is perhaps to be regretted that a substance of such economic importance and scientific interest as bauxite should not have received fuller treatment; and it is rather surprising that no reference is made to the limestone deposits known as 'cornstones' that are so well known in Britain. These, however, are minor blemishes in what is, to all intents and purposes, an entirely new text-book, filling a definite gap in British geological literature. Both Mr. Black and the publishers are to be congratulated on its preparation.

### Rainfall and Tree Growth in the Great Basin

By Ernst Antevs. (American Geographical Society, Special Publication No. 21.) Pp. v+97+2 plates. (Washington: Carnegie Institution; New York: American Geographical Society, 1938.) n.p.

IN recent years drought has become a major problem in the western States, and it is important to study the variations of rainfall over as long a period as possible. In this region there are few rainfall stations with long records—scarcely any before 1871—and the author accordingly set out to supplement these with data from other sources, such as historical records of rains and droughts, crops, the levels of lakes and rivers and especially the annual growth-rings of trees

The area studied includes a number of lake systems in the Great Basin, mainly in Oregon, northern California, Nevada and Utah. Each area is discussed in considerable detail and the results are expressed in curves and tabulations back to about 1850, with curves of tree-growth permitting general estimates for longer periods. The results of this detailed study are then combined in a summary of the major fluctuations of rainfall since 1801, from which the author draws some hopeful inferences as to a future improvement in the water supply. In order to find a parallel to the drought of 1924–34, he has to go back to the 1840's. Since 1887 there have been nearly three complete minor oscillations, but it is doubtful if these are truly periodic, and the predictions of water supply based on them are to that extent uncertain. The final chapters give the curves of tree-growth back to 1450 and discuss their significance.

The book is a most interesting study of historical climatology, bringing together and interpreting several different lines of evidence in a sound and critical way.

### The Application of Moving Axes Methods to the Geometry of Curves and Surfaces

By Dr. G. S. Mahajani. Pp. vii+60. (Poona: Aryabhushan Press, 1937). n.p.

APPARENTLY Routh was the first to turn to account the fact that the curvature and torsion of a space curve represent the components of rotation of the fundamental axes as they move along the curve. It was Darboux, however, who developed fully this application of kinematics.

In the tract under notice, Dr. Mahajani, employing vectors, derives a compact and manageable notation for the equations of relative motion. The Serret-Freult formulæ form a special case; in the author's notation

$$\frac{d}{ds}(l_1, l_2, l_3) = \begin{vmatrix} l_1, l_2, l_3 \\ -\tau, 0, \varkappa \end{vmatrix},$$

where obviously the symbol on the right is to be read in a special manner. By assigning appropriate motions to the representative point, he succeeds in outlining much of the material discussed by means of these formulæ in the usual introductory course, including some results in the theory of curves on surfaces.

The essay shows that, at any rate within the limits which its author has set himself, the method can be an elegant one. It may well appeal to those who find that their need of the subject is not continuous enough to enable them to memorize completely the calculus of the unit vectors $t$, $n$, $b$. A clearer exposition than Dr. Mahajani's could not be wished for.

### Observationes Anatomicae Selectiores: Amstelodamensium 1667–1673.

Edited with an Introduction by F. J. Cole. Pp. xi+45+59+4 plates. (Reading: Prof. F. J. Cole, University, 1938.) n.p.

THIS beautiful little book, of which not more than a hundred copies are to be printed for sale, emanates from the Department of Fine Arts of the University of Reading, and represents a faithful reprint with the preservation of all grammatical, typographical and engraver's errors of two little tracts of the Private College of Amsterdam, copies of which in Great Britain were hitherto only to be found in the British Museum, the University of Glasgow and the Bodleian libraries. In his excellent introduction, Prof. F. J. Cole states that these tracts are the rarest and least known of all the early literature of comparative anatomy. The first tract printed at Amsterdam in 1667 contains notes on the anatomy of the calf, horse, bullock, sheep, swan, duck and dove, and the vivisection of a dog and frog, while the second tract published in 1673 deals mainly with the pancreas of fishes such as the sturgeon, herring, cod, turbot, pike, perch and trout. Of special interest to the biologist are the descriptions of injection of the branchial artery of a calf with mercury, the air sacs of the swan, duck and pigeon, the palatal organ of the carp, the swim bladder and pneumatic duct of the carp, pike and herring, and the ligamentous spiral valve or 'skrew gut' of the sturgeon.

### Civilization and Disease

By Dr. C. P. Donnison. Pp. xv+222. (London: Baillière, Tindall and Cox, 1937.) 10*s*. 6*d*.

THE author, whose work is based on his experience as medical officer in charge of a native reserve in Kenya as well as in private practice in England, maintains that in a small but important number of diseases which can be divided into two groups a relationship can be traced between civilization and the disease. The first group comprises four diseases, namely, high blood pressure, diabetes mellitus, exophthalmic goitre and peptic ulcer, while the second group consists of functional disorders usually known as psychoneuroses. High pressure, it is shown, is rare in primitive races and its incidence increases with development in towns and with education, while it is common in the African in America and very prevalent in Europe and the United States. The same holds good with regard to diabetes mellitus, exophthalmic goitre, peptic ulcer and psychoneuroses. In other diseases, according to the author, there seems to be some relationship with civilization, but the evidence is too inadequate to justify any definite conclusions.

### Primitive Races of To-day

By J. W. Page. Pp. 348. (London: George G. Harrap and Co., Ltd., 1938.) 8*s*. 6*d*. net.

ANTHROPOLOGISTS may cavil at Mr. Page's use of the term 'primitive' as applied to existing peoples of the simpler cultures; but they will not quarrel with the acumen with which he has chosen his authorities, nor the ability with which he has singled out for mention the significant details in the various modes of life and their relation to environment, in these accounts of typical examples of food-gatherers, hunters, cultivators and nomadic herdsmen. The peoples whom he has elected to describe range in distribution from polar snows to the tropical forests of the equator and the islands of the Pacific. Not all still exist to-day as described here; and others, as Mr. Page notes, have long been diminishing in numbers, while rapid changes in culture are universal.

Mr. Page's illustrations are well chosen, and his sketch maps, rough as they are, useful.

### Applied Mycology and Bacteriology

By L. D. Galloway and Dr. R. Burgess. (Modern Chemical Industries Series.) Pp. ix+186. (London: Leonard Hill, Ltd., 1937.) 10*s*.

THIS little book fills the need for a simple introduction to the study and control of bacteria and fungi. The treatment given herein is lucid, comprehensive and accurate. The book may be cordially recommended, therefore, to those, such as chemists and others, having interests in the supervision of foods, water, textiles and perishable goods generally, who wish to obtain some understanding of the agents of decay and how to circumvent them. Even the specializing microbiologist can learn of developments outside his own sphere. Production is good, and misprints are all but absent. H. N.

# Fundamental Aspects of Erosion

By Dr. E. G. Richardson, King's College, Newcastle-on-Tyne

EROSION is a problem of considerable complexity which cannot readily be expressed in terms of known physical laws. Up to the present, it has lain mainly in the sphere of the engineer, who has evolved a number of empirical laws for predicting its magnitude. It is evident by the disagreement not merely in coefficients but even in the functions on which the erosion is made to depend, that these rules are designed only to fit the conditions which fall within the experience of particular engineers and have no universal application. Before further progress can be made in combating the evil, one must attempt to reduce the problem to its simplest proportions.

Pioneer fundamental research in the subject was carried out by Gilbert in 1914 in America, while recently Hjulstrom* in Sweden and I myself† in Great Britain have independently carried out laboratory and field experiments in which the question has been studied under conditions which reduce the variable quantities to a minimum. The factors which then remain can be grouped under two headings: first, those which concern the eroding stream—whether it is in steady motion or turbulent and in particular the value of the gradient of stream velocity at the surface of the soil; secondly, the nature of the soil bed, the size, shape and density of the grains and whether they are closely or loosely compacted.

In field experiments, all these factors intervene in a fashion which does not allow of the separation of their respective contributions. It is desirable, as a basis for establishing the laws of erosion, to make experiments first in artificial channels, using a bed of loosely compacted and nearly homogeneous particles so that the factors just enumerated can be varied one at a time. Measurements are then made of the mean quantity of silt transported at various heights above the bed and of the gradient of mean velocity transverse to the stream in the same vertical section. I have made such observations in a glass-sided channel having a wooden floor on which a bed of sand, graded within fine limits by sieving, was laid. The velocity of the stream along the channel was measured from point to point by a hot-wire anemometer, while the silt concentration at any level was measured photo-electrically in terms of the absorption which a narrow beam of light cast athwart the stream suffered in virtue of the intervening sand carried in suspension. Although the experiments were actually carried out in water, there is no essential difference between the behaviour of air and water in this respect, due regard being paid to their relative viscosities and to the relative buoyancies of the eroded material in the two media.

The disturbing influence on the soil which lifts the grains into the stream is in the main due to the shear on it, that is, the product of viscosity and the velocity gradient at the bed, while the restoring force is determined by the natural rate of sinking of the grains. Under the combined action of erosion and gravitational force, the grains are so distributed that the silt concentration at any level fluctuates about a mean the value of which falls off exponentially with height, at least over the major part of any vertical section. If the bed be changed for one of coarser but still homogeneous particles, the exponent in this relation and with it the total quantity of silt carried in suspension diminishes in consequence of the faster rate of free fall of such particles. If then one plots the height against the logarithm of the silt concentration, a line is obtained which is almost straight (except near the bed) and the slope of which can be taken as a measure of the erosion coefficient. For a given velocity gradient, provided the stream is sufficiently turbulent to afford adequate mixing, this coefficient is found to be inversely as the grain size, bearing out theory in this respect.

Similar considerations apply in natural streams, where the bed, of course, is not homogeneous. Samples taken out of the River Tyne in flood at various depths and analysed in respect of size-frequency give a series of curves the mean slope of which for each size follows the same law. Occasionally it is reported by hydraulic engineers (who measure in terms of surface velocity and slope of bed) that 'colloidal' particles are less easily eroded than somewhat larger ones, so that in a mixed bed there is maximum rate of erosion occurring for a diameter round about one tenth of a millimetre. This anomaly is usually attributed to the superior cohesion which a clay sludge possesses. The exception, however, disappears if one reckons erosion in terms of the velocity

* *Bull. Geol. Inst. Uppsala*, **25**, 221 (1935). This paper contains a bibliography of erosion. Other more recent accounts of (gross) silt transport will be found in *Water Pollution Research, Tech. Paper* No. 7 (1937); *U.S. Waterways Expt. Stat. Paper* No. 17; *U.S. Geol. Survey Water Supply Paper* No. 797; Y. L. Chang, *Proc. Amer. Soc. Civ. Eng.*, Nov. (1937).

† *Phil. Mag.*, **17**, 769 (1934); *Proc. Roy. Soc.*, A, **162**, 583 (1937).

gradient instead of surface velocity, for it is well known that the distribution of velocity across a stream carrying finely divided or colloidal material is not the same as that in homogeneous fluids, or in those in which large crumbs of sparsely distributed soil are in suspension.

The extent to which the soil allows the fluid to permeate it has probably the most important influence in loosening the bed prior to actual erosion. When water passes over the soil a certain amount of chemical action may take place, particularly when the surface soil is a limestone formation, but whether this occurs or not, once the water is able to break up the soil into smaller crumbs or to encircle those which already existed before its passage, it can exert pressure to move the formerly coherent grains, which then become potential silt. Sometimes an actual lifting force may be exerted, that is to say, the line of action of the pressure may be inclined upwards instead of along the bed. This happens notably when a grain is lying a little higher than its fellows on the bed and its foundations are partially or completely undermined by the fluid. The local velocity at the top of the grain is then greater than that beneath, so that the force towards the underside may exceed the total of gravity and the downward force on the top. Such a state of affairs often occurs where a pebble is resting on a sandy bottom, and the resultant force may lift it momentarily into the body of the stream. As soon, however, as it has risen above the boundary layer of fluid in which the major part of the gradient of velocity is found, the lift is lost and it sinks back.

This accounts for the series of long hops by which the heavier particles follow the stream and the ultimate formation of ridges or dunes, but this process does not, in my observation, contribute markedly to the silt load of the stream itself, which is a function merely of the degree of turbulence, velocity gradient and grain size. Penetration of the soil by the eroding fluid can nevertheless change the distribution of velocity near the bed—in fact, at a sandy bottom the gradient of velocity may show a point of inflection separating the domain of quasi-fluid motion above and quasi-solid flow below—and in this way react on the silt load carried in suspension.

How, then, do the means commonly adopted for the prevention of erosion stand in the light of these results? Attempts to lower the overall slope of the land by farming on the terrace system or by obstructions in the form of vegetation would seem to be but partial palliatives, at least so far as water action is concerned, since when the water-level is low the gradient at the bed may still be large, while if the water-level is high over soil of small permeability and the slope or obstruction is effective in keeping down the erosion coefficient, it will hold up the run-off and leave the land waterlogged. What the water engineer requires is a system which will keep the shearing force on the bed small, while not unduly impeding the run-off above. In the case of a river, this desideratum may be secured by a series of check dams or shallow weirs placed at short intervals across its bed. In this way the stream goes down a shallow staircase;

CHECK WEIRS ON THE RIVER ALP, SWITZERLAND.

the main flow is unretarded, but the motion near the bed is almost at a standstill. Such a device is already in use to a certain extent on the Continent, and the accompanying photograph shows how it is applied to the River Alp in Switzerland. To combat 'sheet erosion' on farm lands, application of the same principle suggests the close sowing of dwarf herbage to impede the action of wind or rain within an inch of the soil while leaving free circulation above.

To measure the efficacy of such remedies, it is necessary to take hourly or at least daily readings of the total silt load of rivers and farm drains, and to correlate these with local rainfall. Assuming the exponential relation between silt concentration and depth already noted, it appears that measurement of concentration at two levels will suffice to determine the erosion coefficient; this, together with the average stream velocity, will determine the total rate of silt transport and hence the net total erosion above the observation station. I have

employed an apparatus for this purpose in the Tyne at Newcastle consisting of a pair of light beams and photo-electric cells placed at one third and two thirds of the depth below the surface, the mean flow being measured at the same time on a meter of the rotating vane type. Hjulstrom has made measurements to the same end by actual weighing of silt samples taken out of the River Fyris at Uppsala. It is really surprising what large silt loads can be carried annually by comparatively sluggish rivers. Thus Hjulstrom estimates that the Fyris—normally quite translucent—carries away more than 60,000 tons of material—soluble and insoluble—from its basin every year past the bridge at Uppsala. The figure for the more turbid and fast-running Tyne has not been precisely estimated; but it is considerably in excess of this.

## Research in Freshwater Biology in Great Britain

THE need for a biological station for research on problems connected with freshwaters was emphasized at the meeting of the British Association at Glasgow in 1928, and this led to the foundation of the Freshwater Biological Association of the British Empire in 1929. Two more years of active work on the part of the many men of science and others interested in the project elapsed before the laboratory was founded at Wray Castle on the shores of Windermere in 1931. At first there were but two members of staff, making the best of a few rooms without laboratory fittings, but from 1931 until the present year progress has been rapid, as is well shown by the recently issued sixth annual report*.

The whole of Wray Castle is now occupied, there being on the ground-floor seven laboratories, fitted with adequate benches, sinks, electric light, power and gas, and upstairs a library, offices, and a number of living rooms capable of housing the unmarried members of the staff and up to a dozen scientific visitors. There are now seven resident scientific investigators: Dr. E. B. Worthington (director), five assistant naturalists, and a bacteriologist, who cover all the major branches of the subject. These, together with secretarial and laboratory staff, should place Wray Castle among the foremost freshwater biological stations in the world, and make it capable of carrying out work of national importance.

The interests most closely concerned with freshwater biology may be grouped into three categories—academic research, fisheries and water-supply—and each contributes materially to the finances of the Association. Accordingly, some limit has to be put to the scope of the work which is undertaken, those subjects being chosen which are likely to elucidate the factors which control the production of life, both qualitative and quantitative. The extent and variety of waters within easy reach of Wray Castle give ample scope for work on the many subjects involved.

* The Freshwater Biological Association of the British Empire. Sixth Annual Report for the Year ending March 31st, 1938. Price to non-members, 1s.

One promising line followed up during the past twelve months is connected with the bottom deposits of lakes. With the co-operation of the Hydrographic Department of the Admiralty, a detailed bathymetric survey was made of Windermere by the new supersonic echo-sounding method. The records revealed not only the depth of water but also the thickness of soft deposits overlying the glacial basin. In addition, cores of the deposits have been obtained and appear to reveal a succession of cold and warm phases during the early history of the lake, so that a good opportunity exists for adding to knowledge of the post-glacial history of the district. This research has more than historical significance because the use of the echo-sounding machine to demonstrate the thickness of soft deposits below a considerable depth of water has an immediate application to reservoirs, where the accumulation of mud may lead to greater production of algæ, and other troubles in filtration and purification of water for domestic purposes.

Work in past years by Prof. W. H. Pearsall, Mr. R. Misra and others has demonstrated the great importance of the character of bottom muds in controlling the chemical (especially nitrogen) balance, and also the plant and animal associations. Here an investigation at Wray Castle on the bacteriology of lakes, streams and bottom deposits, which is being financed by the Department of Scientific and Industrial Research, may be very significant. Attention will be devoted by Dr. C. B. Taylor, who has been appointed to the new post, primarily to the part played by bacteria in the nitrogen and phosphorus cycles. Closely linked with this is Dr. C. H. Mortimer's work on the chemical budget of a whole drainage basin. This has involved routine chemical analyses and the measurement of water-flows of rivers throughout the year, in order to estimate the quantity of different salts entering and leaving Windermere. The effect of chemical factors on the growth of algæ is studied by Dr. M. Rosenberg by correlating the quality and quantity of algæ, as observed in natural conditions, with the chemical

content of water at different depths and at different times of the year. In addition, many species of algæ have been taken into pure culture in the laboratory, where their reactions to altered conditions, in rate of multiplication and morphological change, can be studied under controlled conditions.

This brings us to the work on animals, and here freshwater biology is still suffering under a disadvantage because the basic faunistic studies, such as were characteristic of the early work in marine biology, have never been properly undertaken. The taxonomy of the aquatic stages of winged insects, for example, is still in a lamentable state, although work at Wray Castle on breeding ephemerids, caddis-flies and stone-flies is now helping materially in this direction. It is in the hands of Mr. T. T. Macan, who is working on the ecology of the Invertebrata, devoting special attention to corixid water-bugs. Such studies are specially necessary in view of the importance of most of the groups as fish-food.

Of the fish themselves, most attention has been given in the past few years to the salmon, the freshwater life of which up to the stage when smolts reach the sea is being studied by Mr. K. R. Allen. By detailed work in three widely separated parts of the British Isles, the Lake District, the extreme north of Scotland, and the south of England, he is obtaining comparative data of value in determining the factors which control their growth-rate and behaviour. A new fish study is concerned with the so-called 'coarse fish', which contribute so much to the health and recreation of a large section of England's population. This investigation has been financed by the fishing interests, and Mr. P. H. T. Hartley, recently appointed to undertake the scientific work, has a sure backing from the National Federation of Anglers.

There is another aspect of the Association's work, connected with parts of the Empire other than Great Britain. Already Wray Castle has served some purpose as a centre for information on freshwater fisheries in Africa, where the director has had extensive experience of research. Local problems of fisheries or water-supply are bound to become more numerous as Colonial development proceeds, so that the Freshwater Biological Association may have opportunities of extending its usefulness in this direction.

Viewing these activities as a whole, it may perhaps be fairly claimed that the laboratory at Wray Castle, though still young, is well on the way to becoming a worthy partner of its elder brother—one might almost say father—the Marine Biological Association's Laboratory at Plymouth.

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# Analytical Methods in the Dating of Books and Documents

By Dr. Julius Grant

THE problem of establishing the date of origin of specimens of paper, for example, from books or documents, is one which arises frequently, but which is seldom solved without controversy. In many such cases, suspected forgeries of valuable first editions of books are involved, whilst others are concerned with forgeries also, but possibly of greater criminological interest. Where written documents are in question, the ink expert has in the past usually been able to provide the strongest links in the chain of evidence, although with printed matter his contributions are necessarily restricted. However, since the date of the manufacture of the paper must always precede that of the application of ink (whether as handwriting or as print), the date arrived at as the result of an examination of the ink must always represent the paper as younger than it really is, and when the gap between the two dates is a big one, serious errors in dating may arise.

In addition to that obtained from the ink, useful evidence has in the past also been drawn by the book expert from the nature of the type used, the format of the book, the binding, the illustrations and so on; these are all characteristics which demand an intimate knowledge of book production and its history. In spite of this, there have been many instances where evidence of this kind, based as it must be largely on personal opinion, has proved inconclusive and even contradictory.

The paper has, of course, also contributed its share of evidence, although not to the extent merited by the importance of the information it is capable of supplying. This may have been due to inadequate co-operation between the experts on bibliographical and paper-making matters, and possibly to indifference to the interest and value of such studies on the part of the latter. The importance of paper, particularly where the examination of first editions is concerned, depends to a great extent on the fact that, unlike printing type, the format of the book and so on, it is most difficult if not impossible to make a completely successful imitation of a given paper without employing the same materials and equipment as those used in the original. Watermarks may be

imitated, although these can now be detected with the aid of ultra-violet light (see J. Grant[1]), and the character and appearance of a particular paper may be simulated, but as a rule a few comparatively simple analytical tests will reveal any essential points of difference.

Relatively new ground, therefore, was broken by J. Carter, and G. Pollard[2] when they used the fibre content of the paper as a means of dating it. These workers were concerned principally with certain nineteenth century pamphlets, including works by Tennyson, Dickens, the Brownings and others, which were alleged to be genuine first editions. Thus one particular case referred to a copy of Tennyson's "Morte D'Arthur" which was dated 1842; when this was suspected, the fibre content of the paper was determined and was found to include esparto grass and wood pulp which had been prepared by a chemical process. Since esparto was first processed in 1861 and wood some twenty years later, the forgery stood revealed without any doubt.

It is apparent that the extension of this method of dating by reference to the introduction of a new raw material is full of possibilities, and since the work of Carter and Pollard this line of investigation has been pursued with highly successful results in many cases. As explained below, however, there are many instances where the value of the method is only as a supplement to evidence obtained from the usual sources. Two obvious conditions must in fact be satisfied in order that this type of test may be applied with any degree of reliability. In the first place, the earliest date when the material in question was first used in paper-making must be known accurately; and in the second, a trustworthy method of establishing the presence of this material must be available. Incidentally, as indicated below, one is not restricted to tests for the actual constituents of paper; new methods of manufacture serve the purpose equally well, so long, of course, as the two conditions specified above are fulfilled. If enough characteristics of the above kinds can be assembled, it is conceivable that the date of origin of a paper may be 'sandwiched' between any two of them, and possibly be deduced to within a few years.

There is no lack of suitable analytical methods for this work. Unfortunately, there is less certainty regarding the years when some materials or processes were first used, and this places the principal restriction on the method. Many innovations are not recorded in the literature, having been worked secretly in the first instance; others are hidden in the obscurities of the early patent literature. In such cases, all that the method can do is to supply evidence that a paper which reacts positively to the test in question was made after the date of the earliest reliable record available. The importance of this proviso is greatest when papers made before the middle of the last century are under consideration, because the records of invention become progressively fewer as one goes back chronologically. In the future, on the other hand, this method of dating will become increasingly more valuable, because each year sees a fresh contribution to the technology of paper-making, and most of these can be detected and dated reliably.

Some examples of the application of these analytical methods will now be given. They fall into two main categories, namely, those involving the constituents of the paper, and those based on innovations in paper-making technique. As already pointed out, Carter and Pollard are the pioneers of the former method, although their work was restricted to tests for rag, wood and esparto fibres. This system may, however, be extended considerably, because several kinds of wood, as well as other fibres such as straw, are also used in paper-making.

Up to the beginning of the last century, 'rag' fibres (that is, mainly linen or cotton) were the only materials of paper-making. At about this time (1804) paper was first made by machine, as distinct from hand, and incidentally this is itself a reliable milestone, because a machine-made paper is easily recognized, and must be later than 1804. Owing to the rising standard of education, the demand for paper increased rapidly, and this led to an acute shortage of rags, the position being such that in 1854 a prize of £1,000 was offered by *The Times* for the discovery of a suitable substitute. Straw was the first-comer in the field, and by 1860 mixtures of straw and rags were common; as they gradually declined in popularity (in Great Britain in any event) after the advent of esparto in 1861, such mixtures serve to date a paper as certainly later than 1855, and probably as between 1855 and 1870.

Similarly, there was a transition period when mixtures of esparto and rag—a rare mixture nowadays—were quite common, and these serve to date a paper as certainly after 1861 and probably earlier than 1890. Wood was the next raw material, and of course in a relatively short time this became the most important of all fibres, at any rate so far as the cheaper grades of paper (for example, for books) were concerned; full use of this is made by Carter and Pollard. It should be pointed out, however, that within recent years the investigator has been enabled to distinguish between woods of different types and prepared by different processes, from a microscope examination of the disintegrated fibres of the paper. Incidentally, fluorescence microscopy in ultra-violet light (see J. Grant[3]) has proved of considerable assistance in

this connexion. It is thus possible to distinguish not only woods prepared by the mechanical process and by a chemical process, but also woods prepared by different types of chemical processes (for example, by the acid and alkali methods of digestion), and as the dates at which these processes were introduced are known accurately, these analytical tests may prove of considerable aid in dating.

Even to-day new fibres continue to appear. Bamboo is an example, and it indicates that a paper is of Indian origin and probably later than 1930. Straw, also, can now be produced having a colour and degree of cleanliness which enable it to be used in fine papers, and other recent additions to the paper-makers' fibres are bleached kraft, alpha-pulps and cotton linters; these all have a certain amount of dating value so far as modern papers are concerned. Incidentally, the fibrous composition of a piece of paper may be ascertained by examination under the microscope of a few fibres scratched inconspicuously from the edge of the sheet; this has obvious advantages where a valuable document is concerned.

The fibres are not the only constituents of paper which have a dating value; thus, sizing materials, loadings and colourings may all play a part. Sizing provides an interesting example, because there seems little doubt from the literature that rosin was first used for rendering paper non-absorbent towards ink in about 1800, but that its use was confined to Germany until about 1835. Rosin in paper may be detected with relative ease and certainty, and since the period around 1835 is one for which dating evidence is none too abundant, this fills an important gap. Loadings may be of interest partly because of their chemical nature, and also by reason of the quantity present in the paper. This is because when, with the advent of machine-made paper, it became usual to sell paper by weight instead of by the sheet or ream, many paper-makers succumbed to the temptation to add to the former by the use of excessive quantities of loading. The weakening effect on the paper was such that public opinion soon put a stop to this practice, except for certain classes of paper (for example, for the reproduction of illustrations), but there is a certain period (after 1820) when papers containing 30 per cent of loading were common. Such papers are easily recognized, because unless they have been stored under particularly favourable conditions, the effects of ageing are strongly in evidence; in many cases they fall to pieces at a touch (cf. J. Grant[4]). A recent addition to the loadings used in many papers is titanium dioxide and the white pigments associated with it; these are easily detected, and place the paper without any doubt as later than 1930.

Coloured papers are seldom used for important documents, although they can often supply very useful dating evidence. Aniline dyestuffs, for example, were not used in paper to any great extent between the year of the discovery of the first of them (1856) and 1870, but after the latter date they became common. The dating value in cases where the actual dye used can be identified is considerable, because the patent records provide a trustworthy key to the history of the dyestuffs industry. The mineral pigments used for colouring paper before the advent of synthetic dyestuffs also have a certain amount of dating value. Ultramarine is the commonest of these, and according to legend its use in paper originated from the mistake of a paper-maker's wife who dropped her 'blue-bag' into her husband's pulp vat instead of into her own wash-tub, which stood adjacent to it in the home-factory of those days! Whatever the details of the discovery, the date of its occurrence (about 1790) is known, and as ultramarine is easily detected, it may be used as an aid to the dating of blue papers of this period.

Finally, those improvements in paper-making technique which have left their mark on the physical structure or character of the paper may have considerable dating value. Watermarks provide one example, although their importance, as indicated above, is limited. The transition from hand-made to machine-made paper has also been mentioned, while I have found that the use of the beater instead of the stamping mill to prepare the pulp is an important dating characteristic, because it took place at a period (about 1670, on the Continent) for which little other dating evidence is available. Unfortunately, the identification of such paper, which is carried out by examination of the fibres under the microscope, is not always easy. Calendered papers are, however, more easily recognized and date from 1830; and coated papers, which are used for illustrations, frequently serve to date the paper constituting the remainder of a book in which they are inset, because it is known that they were first made in 1890.

The examples given above might be supplemented considerably. It is believed, however, that they suffice to indicate the possibilities of the application of analytical methods to the dating of paper. As already pointed out, the importance of the method should increase considerably as time goes on, because of the increasing number of new methods and materials now being introduced into the industry, and the fact that the dates of their introduction are known with accuracy.

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# Obituary Notices

## Prof. J. J. Abel, For. Mem. R.S.

NEWS of the death of John Jacob Abel on May 26 last was received with the deepest regret by pharmacologists all over the world as well as by a much wider circle of those who knew the man himself and could assess the value of his work and influence in advancing medical knowledge generally. He was one of the few surviving links with the beginnings of pharmacology as a separate discipline.

Abel was born at Cleveland, Ohio, on May 19, 1857, and entered the University of Michigan at nineteen years of age. He obtained the degree of Ph.B. there in 1883, after which he spent a year in graduate study at Johns Hopkins University. In 1884–88 he studied chemistry, physiology, pharmacology and medicine in various universities in Germany, and in 1888 took the degree of M.D. of the University of Strasburg. He spent a further two years in Vienna and Berne, and in 1891 returned to America as professor of materia medica in the University of Michigan. Two years later he became the first professor of pharmacology in Johns Hopkins University, a position which he held with so much distinction until his retirement in 1932.

The first Institute specially devoted to pharmacology was founded at Dorpat in 1847 by Rudolph Bucheim. Bucheim was succeeded at Dorpat by his assistant Oscar Schmiedeberg who, in 1873, was called to the University of Strasburg, and there established an Institute of Pharmacology, which soon attracted workers from all parts of the world. Abel was one of these, and he had thus, through Schmiedeberg, connexions with the beginning of pharmacological laboratories. When new positions in pharmacology were first created, most of those who were called to fill them had worked in Schmiedeberg's laboratory, and Abel from his work in this and other European universities came to have a personal knowledge of those men who afterwards became the pioneers of pharmacology throughout the world. Another of Schmiedeberg's pupils, A. R. Cushny, was selected by Abel to succeed him at the University of Michigan, and these two men exercised a guiding influence upon the development of pharmacology in the United States.

In 1909, Abel founded the *Journal of Pharmacology and Experimental Therapeutics*, which was the first pharmacological journal published in English, and in the editorship of which he was later joined by Cushny. The journal is now the organ of publication for both the American and British Pharmacological Societies. In all that concerned the early development of pharmacology in English-speaking countries—in the establishment of new laboratories, in the selection and training of young men to fill newly created positions and in providing a channel for the publication of their researches—Abel played a dominant part.

This influence, however opportune and important for the development of pharmacology, could not have become so great had it not been supplemented and vitalized by the brilliance of Abel's personal achievements and by the example of his patient and persistent devotion to research. One of his earliest investigations was concerned with the occurrence of aliphatic sulphur compounds in the animal body. This experience helped him later in the successful crystallization of insulin, for he had found that fractions of insulin preparations contained labile sulphur in proportion to their hypoglycæmic power. He was one of the earliest workers on hormones, and succeeded in obtaining an active principle of the suprarenal gland in the form of a monobenzoyl derivative which he called epinephrine. Later Takamine obtained the free base, adrenaline. The determination of the chemical constitution of adrenaline and the discovery that it was a relatively simple body gave an impetus to that study of the constitution of other hormones which has developed so rapidly in recent years. Abel himself later found adrenaline in the secretion of the skin glands of the toad, *Bufo agua*.

In another direction Abel did pioneer work, in devising a method, 'vividiffusion', whereby blood from a living animal could be diverted through a dialysing apparatus and then returned to the body. A study of the dialysates showed the constituents that occur free in the blood.

Abel also studied the active principles of the poisonous mushroom, *Amanita Phalloides*, and found two active principles, a hæmolysin and a non-hæmolytic toxin, the latter being responsible for the toxic effects of the fungus when ingested. Abel and Rowntree investigated various phthalein derivatives with the primary object of obtaining a purgative suitable for hypodermic use. They found that phenolphthalein was excreted solely by the kidney, and this led to its use later as a test for the functional activity of the kidney. Halogen substitution products of phenolphthalein were found to be excreted in the bile only, and this led to the development of tests for liver function by such compounds.

Abel worked also on the action of convulsant dyes, on the physiology of the lymph hearts of the frog, and did some of the early work in the newer domain of chemotherapy in his investigation of the action of antimony compounds in experimental trypanosomiasis. His work covered a wide field, as did that of most of his contemporaries in pharmacology, and was always characterized by imagination as well as by the skill and tenacity with which he pursued a problem.

After his retirement in 1932, Abel still had a room in Johns Hopkins University and up to the end was actively prosecuting researches on tetanus toxin. I still retain a vivid memory of listening to Abel, three years ago, when he outlined the purport of this investigation with all his wonted enthusiasm and modesty.

Abel was the recipient of many academic honours and became honorary or foreign member of many learned societies in many countries. Perhaps none would have given him greater pleasure and satisfaction than his election as foreign member of the Royal Society, which took place only a few days before his death.

During the time in which pharmacology has been emerging as a separate science with its own laboratories and followers, Abel has been an outstanding personality to whom that science must for ever remain in debt. His tall spare figure and genial presence will be sadly missed not only in his own country but also wherever men forgather who are interested in the progress of medical research. J. A. GUNN.

## Sir Colin Mackenzie

WE regret to announce the death of Sir Colin Mackenzie, formerly director of the Australian Institute of Anatomy, at the age of sixty-one years.

Though Sir Colin gained great distinction as an orthopædic surgeon yet he devoted himself to anatomy with an enthusiasm that might be expected to flow only from great genius. He was lecturer and examiner in anatomy in the University of Melbourne. He was a member of the Anatomical Society, served eagerly the Zoological Society of his city, established and furnished a whole museum with dissections of marsupials, strove to secure the preservation of the Australian fauna, and wrote their comparative anatomy in four volumes. His faith in anatomy induced the Commonwealth Government to erect in its Federal capital an anatomical institute under his direction.

Sir Colin's book, "The Action of Muscles", contains an epitome of his anatomical observations and ideas. In about fifty pages, under the title of principles, he states what he has come to believe about muscles. The reader is constantly referred to what happens in the wombat, frequently assured that the action of muscles can only be understood by an appeal to their evolutionary history, and is admonished to consider the behaviour of the primates and the assumption of the erect posture. The principles which he enunciates owe nothing to these allusions to the primates or to the illustrations of marsupial anatomy. The dissections of the wombat seem quite irrelevant to his principles of muscle action which have to do with the treatment of paralysis.

More than thirty years ago, when the treatment of fractures and muscular palsies was very bad, Mackenzie was preaching and practising his principles. He pointed out the error of describing a muscle as paralysed because it was unable to perform its maximum amount of work. More careful inquiry might discover that such a muscle still had some power. The muscles of the shoulder might not be able to lift the limb against gravity, yet perhaps could swing the arm from the side when the body was horizontal and gravity thus excluded. Inflamed nerve cells like any other inflamed tissue must be put at rest. A motor nerve cell could only be rested through its muscle. A muscle is placed in a state of physiological rest when its antagonists are kept overstretched. Thus by rest, and then utilizing the residual power left in an affected muscle, by patience and persistence he accomplished much. Muscle and tendon transplants were advised only when re-education seemed hopeful. He cut through much that was unimportant in the teaching of muscle action by his blunt insistence that a muscle had always one prime action to perform and only co-operated fully in other actions after its prime action had been fulfilled. He insisted upon muscle re-education and saw that this was only hopeful when the alteration of the attachments demanded the least change in function and when there was greatest cerebral control. Thus the gain in usefulness was in general far greater in the arm than in the leg.

His work in mitigating the terrible consequences of infantile palsy led to far greater interest in these matters. His experience was made available in the orthopædic hospitals of Great Britain during and after the Great War. In his own city more people skilful in these matters are available than perhaps anywhere else. He deserves an honourable place amongst "The Menders of the Maimed".

## Miss D. M. Liddell

WE regret to record the death, which took place on May 25 at the Old Rectory, Stratfield Turgis, Basingstoke, of Miss Dorothy Mary Liddell, well known as an experienced and fortunate excavator on archæological sites.

Much of Miss Liddell's early experience and training in archæological work was gained by her participation in the excavation of the famous Windmill Hill site of neolithic culture, explored by Mr. Alexander Keiller. The effect of this training, combined with a natural flair for archæological work, were used to full advantage in her discovery and patient exploration of the Roman house at Lodge Farm, North Warnborough, and also in the discovery and examination under the auspices of the Hampshire Field Club of the extensive pit-dwellings at Chosely Farm, Odiham. Previously she had spent some seasons at work on Chilworth Ring, on Meon Hill. Her most lasting contribution to archæological analysis, however, is probably the patient and detailed study she made of stamped impressions on neolithic pottery. The results of prolonged examination of innumerable specimens of potsherds and of a prolonged series of experiments and photographic work were embodied in an article in *Antiquity* in 1929, "New Light on an Old Problem", in which the central idea of the use of bird bones as an instrument of ornamentation had been suggested to her by the discovery of a large quantity of "West Kennet" pottery associated with a small bird bone.

WE regret to announce the following deaths:

Prof. E. W. Brown, F.R.S., emeritus professor of mathematics in Yale University, an authority on lunar theory, aged seventy-one years.

Mr. G. Nevill Huntly, consulting chemist, on August 2, aged seventy-one years.

# News and Views

## L'Abbé Breul

M. L'ABBÉ BREUIL, professor in the Institut de Paléontologie Humaine and of prehistory in the Collège de France, has been elected a member of the Académie des Inscriptions et Belles Lettres. This signal honour is conferred in recognition of his work in prehistory and more especially of his studies of the art of the palæolithic age. The Abbé has now been recognized for nearly a generation as the foremost authority on prehistoric archæology not only in France, but also in the whole world; and his opinion on any disputed point is universally regarded as a court of final appeal. His election to the Academy is a matter of peculiar gratification to his colleagues in France, as it is the first occasion on which the study of early man and his culture has been honoured officially in this manner; for although de Quatrefages was a member of the Académie des Sciences and Hamy of the Académie des Inscriptions, while Cartailhac was a corresponding member at Toulouse of the latter body, they received these honours, as the editor of *L'Anthropologie* points out in the current issue (48, 1938, p. 391), not in virtue of their eminence in anthropological studies, but on the ground of other qualifications—de Quatrefages as zoologist, and Hamy for his work on the history of geography and geographical exploration.

## Dr. Leo Jolowicz

ON August 12, Dr. Leo Jolowicz will celebrate his seventieth birthday. For many years he has occupied an outstanding position in the German scientific book and publishing business, and has done very much to foster and promote the development and diffusion of the results of scientific research. About fifty years ago, he took over the book business of Gustav Fock in Leipzig, which under his leadership became the largest and best-known 'Antiquariat' of scientific books. Dr. Jolowicz founded the famous publishing house, the Akademische Verlagsgesellschaft. This firm publishes a large number of well-known scientific journals, including, for example, the *Zeitschrift für physikalische Chemie*, and many important standard works and reviews, among which may be mentioned the "Handbuch der Experimentalphysik", "Handbuch der Radiologie", "Rabenhorst Kryptogamen-Flora", "Bronns Klassen und Ordnungen des Tierreiches", "Ergebnisse der Enzymforschung", "Ergebnisse der Vitamin- und Hormonforschung", etc. Among the world's famous publishers who through their deep interest in, and knowledge of, science and learning and their enterprise and imagination do so much to promote the advance of civilization, Dr. Jolowicz occupies a prominent and honoured position.

## George James Symons, F.R.S. (1838-1901)

ON AUGUST 6, occurs the centenary of the birth of the distinguished meteorologist George James Symons, in whose honour the Symons Medal of the Royal Meteorological Society was founded. Born in Queen's Row, Pimlico, he was educated at St. Peter's School, Eaton Square, London, and at Thornton Rectory, Leicestershire, and passed through the Royal School of Mines. Having joined the British Meteorological Society in 1856, the following year he undertook the duties of meteorological reporter to the Registrar-General, and these he continued to discharge until his death. For three years, 1860–63, he also served under Rear-Admiral Robert FitzRoy in the Meteorological Department of the Board of Trade, which had been inaugurated in 1857. His services to meteorological science were many and varied. In 1860 he published the first volume of his "British Rainfall", which gave rise to the British Rainfall Organization, the work of which was transferred to the Meteorological Office in 1919, and in 1866 he founded *Symon's Meteorological Magazine*, which in 1920, with the *Meteorological Office Circular*, was incorporated with the *Meteorological Magazine*. For two periods he served as honorary secretary to the Royal Meteorological Society, and in 1880 and 1900 was the president. So early as 1876 he received a Telford premium from the Institution of Civil Engineers for a paper on floods and water economy, and in 1897 he was awarded the Albert Medal of the Royal Society of Arts for the service he had rendered engineers engaged on water supply problems. His death took place on March 10, 1900, and he was buried in Kensal Green Cemetery. The following year a fund of more than £700 was subscribed for founding the Medal bearing his name.

## Sir James Barrett's Reminiscences

SIR JAMES BARRETT, chancellor of the University of Melbourne, has contributed to *The Herald* (Melbourne) during April and May of this year a series of reminiscences which deal with the history of old Melbourne and its University and Hospital, early days in London and on the Continent, recollections of the Great War, and education and university extension in Great Britain and the United States. Born and spending his boyhood in old Melbourne, when there were toll gates on the St. Kilda Road, Sir James entered the University there when he was fifteen years old, and graduated in the medical faculty in 1881. He recalls the kindly assistance given to students by Prof. Halford, who taught anatomy, physiology and pathology, at a time when the University had only two hundred students with five professors to teach them, and describes medical

practice in Melbourne Hospital in those pre-antiseptic days. He proceeded to London in 1883, obtained the fellowship of the Royal College of Surgeons, London, became demonstrator of physiology in King's College, London, under Gerald Yeo, and commenced his career as an ophthalmic surgeon as assistant at Moorfields Eye Hospital. Interesting recollections are given of Bowman, McCarthy and Michael Foster, Gaskell and Langley, and Jonathan Hutchinson and Whittaker Hulke, all well-known figures in the medical world of the time; he also visited the Continent, and met Koch in Berlin. Then come recollections of the Great War, and the organization of the medical service in Egypt. The organization of "bush nursing centres" in Australia is recounted, a scheme initiated in 1908 by the Countess of Dudley, and finally, Sir James has a good deal to say upon education and university extension, and recalls some of his meetings with British statesmen.

### The British Medical Association: Plymouth Meeting

Dr. Colin Lindsay presided at the one hundred and sixth annual meeting of the British Medical Association, held at Plymouth on July 19 and following days. "The Profession and the Public" was the title of the address of Dr. Lindsay, who pointed out that his remarks were based upon an experience of forty years as general practitioner and consulting physician. He emphasized the need for continued education both for the public and for the practitioner, and the necessity that exists for a specialist service to supplement the service of the family doctor, for medicine has grown so enormously that it is quite impossible for any one person to be proficient in every branch. He reminded the public of the unity and equality of the three main branches of the profession—the general practitioners, the consultants and the members of the public health service—which are essentially complementary, each requiring for its proper performance attainments of the highest order. He desires to see more attention paid to the treatment of the so-called 'minor ailments', for it has been estimated that forty per cent of all sickness is due to the patient's own action. The principle of 'free choice of doctor' under National Health Insurance was stressed, and the Association's proposals for a general medical service for the nation were outlined, by which members of families within an income limit of £250 a year would be included. Other topics dealt with were the fees to be paid for consultative work, the education of the public in the use of the doctor, and the countering of credulity on the part of the public.

### Lister Institute of Preventive Medicine

The report of the Governing Body of the Lister Institute of Preventive Medicine, presented at the annual general meeting on June 2, gives an account of the researches carried out at the Institute during the past year. Several studies on viruses, vaccinia and others, are detailed, with an investigation on the problem of rheumatic diseases, in which virus-like bodies occur. Dr. Felix and others have continued their work on the antigenic constitution, virulence and immunizing properties of bacteria and Protozoa, and the chemistry of bacterial antigens has also been investigated. The Svedberg velocity ultracentrifuge, installed some time ago, has given satisfactory service, and several proteins have been the subject of study with this instrument. Many studies on vitamins, their chemistry and action have been prosecuted by Dr. Harriette Chick and her co-workers. The Institute is the home of the National Collection of Type Cultures, and more than 6,000 cultures have been distributed to workers at home and abroad. Sir John Ledingham, the director, his staff and attached workers may be congratulated on their fine output of work.

### Medical Classics

Two important medical classics which were recently published in the *Bulletin of the Institute of the History of Medicine* have just been reprinted in book form and thereby made accessible to a wide circle of readers. The first of these, entitled "On Thought in Medicine", is the address delivered by Hermann von Helmholtz on August 2, 1877, on the anniversary of the foundation of the Institute for the Education of Army Surgeons. In this address, Helmholtz attacks the old educational system which he regards as pursuing a false idea of science, in which there is a one-sided and erroneous reverence for the deductive method. Medical education during the early part of the nineteenth century in Germany was based mainly on the study of books. There were no physiological or physical laboratories, and microscopical demonstrations were infrequent in lectures. It fell to Johannes Müller and his pupils, of whom Helmholtz was one, to stimulate the study of microscopical and pathological anatomy, experimental pathology and therapeutics and to substitute experimental research for untried and unconfirmed hypotheses.

The second volume contains a translation of Ivan Sandström's work entitled "On a New Gland in Man and Several Animals (Glandulæ Parathyroideæ)", which was published in vol. 15 of the Swedish journal *Upsala Läkareförenings Förhandlinger* for 1879–80, and represents the first detailed description of the parathyroid glands, based on the naked-eye and microscopical examination of these glands in the dog, cat, rabbit, ox and about fifty human subjects. It is noteworthy that whereas the translation of Helmholtz's address was published so long ago as 1893, the English version of Sandström's monograph now appears for the first time, and has been carried out by Dr. Carl Seipel, who has also translated an account of Sandström's life and work by Prof. A. J. Hamman of Stockholm.

### Jubilee of the Gypsy Lore Society

This year the Gypsy Lore Society celebrates the fiftieth year of its existence. The occasion was marked by a jubilee dinner on June 11, over which Lady Arthur Grosvenor (president, 1913–14) pre-

sided in the unavoidable absence of the president, Mr. Augustus John, and at which fifty-five members and guests were present. The Gypsy Lore Society was founded in 1888 by Charles Godfey Leland ("Hans Breitmann") and David MacRitchie of Edinburgh. Leland's enthusiasm for gypsy studies, characteristically overpowering, dated from 1870, when he settled in England for a period of years. Although he wrote several books on the gypsies between 1873 and 1882, it was not until 1888, three years after his return to England, that his desire to promote a wider interest in the investigation of the gypsy problem took practical shape in the foundation of a society devoted to that object; and indeed its formation was owing largely to his association with the organizing ability and scholarly habit of mind of MacRitchie, to whom also was due, with John Sampson and R. A. S. Macfie, the resuscitation of the Society in 1907, when it had been dormant for a period of years through lack of funds. Among the eleven original members, who formed the nucleus of the Society, were H. T. Crofton, Elizabeth Robbins Pennell, Leland's niece, famous as an interpreter of Ibsen's heroines on the stage, the Archduke Joseph of Austria, a fluent Romani linguist, Sir Richard Burton, the famous, if difficult, orientalist and traveller, Paul Bataillard, F. H. Groome, most eminent of the early students of gypsy folk-lore, and Walter Herries Pollock; while one of the earliest adherents in the United States was Mary Alicia Owen, later known as an authority on the folk-lore of the American Indian, whose early studies of the traditional tales and beliefs of the negroes of Missouri, if modelled on the "Uncle Remus" of Georgia of Joel Chandler Harris, were directly inspired by Leland's encouragement.

IN an introductory article which opens a special jubilee number of the *Journal of the Gypsy Lore Society*, the editor, Archdeacon F. G. Ackerley, enumerates some of the more noteworthy contributions to the investigation of the gypsy problem which have appeared in its pages and elsewhere since the foundation of the Society. Among contributors to the *Journal*, the late Dr. John Sampson naturally takes a high place, not only on account of his linguistic studies, but also for his collection of Welsh Romani folk-tales; but it will be generally agreed that the term 'epoch-marking' here applied to Prof. R. A. S. Macalister's collection of material bearing on the language of the Nawar of Palestine is appropriate in more than a conventional and complimentary sense. It gave a new orientation to the study of the gypsy problem. Outside its own publications, the influence of the Society is to be seen in Dr. John Sampson's "Dialect of the Gypsies of Wales" (1926), which has been termed "the best of all Gypsy linguistic studies in any language" and Prof. E. Pittard's "Les Tsiganes ou Bohémiens" (1932) in which "is presented once and for all the physical anthropology of the race". Two great services the Society has performed for gypsy studies: it has abolished the pseudo-romantic rubbish which formerly passed for gypsy-lore, and it has exploded the popular association of gypsies with Egypt by laying down the true lines for the investigation of the problem of their origin. It is difficult to say which has been the greater service to learning.

## Archæological Collections in Spain

NOTWITHSTANDING reports of damage sustained by archæological collections in the museums of Madrid, it is now announced that an official verification by the Ministry of Public Instruction and the Municipality of Madrid has established the fact that the collections of both the Archæological Museum and the Anthropological Museum of Madrid are intact. Prof. Bosch Gimpera, to whom the editors of *L'Anthropologie* (**48**, 3–4; 1938) are indebted for the information, goes on to add that the other museums of the area under the Republican Government have been preserved from damage, while the official departments responsible for antiquities are taking every necessary precaution for their safety. As regards the museum at Valencia and the Catalan museums, Prof. Bosch Gimpera, as head of the antiquities service, is able to give his own personal assurance of their safety to his archæological colleagues outside Spain.

## Italian Anthropological Expedition to Erythraea

ON his return at the close of last year from an expedition to the Tana basin of Ethiopia, Prof. L. Cipriani, director of the Anthropological Laboratory of the University of Florence, was forthwith placed in charge of an anthropological mission to northern Erythraea for the purpose of studying the little-known peoples north of Cheren. This mission was under the joint auspices of the Royal Academy of Italy and the Bureau of Colonial Studies of Florence. The expedition lasted from December 1937 until March 1938. According to a preliminary note of the results (*L'Anthropologie*, **48**, 3–4; 1938), anthropometric measurements were made of 450 subjects, of whom there were 70 Bogo, 94 Mària, 26 Habab, and 159 representatives of groups adjacent to the last-named. For purposes of comparison, measurements were also made of 29 Abyssinians, as well as 30 Baria women and 20 Rasciàida. The blood groups were tested in 110 subjects. A further result of the expedition was the discovery of a large number of rock paintings in the granite caves of Carora near the Anglo-Egyptian frontier, as well as of stone implements of palæolithic type, the first to be recorded in Erythraea. Finally the expedition brought back to Italy 68 masks taken from the living, and more than two thousand photographs of ethnographical and anthropological subjects.

## Stone Age Village in Yorkshire

NOW that archæological research aims at the reconstruction of a cultural phase as a whole, rather than at bringing to light by excavation individual antiquities of exceptional interest or artistic merit, the announcement of the discovery of a remote but complete village of the stone age at Rinyo on the Island of Rousay, Orkney (*The Times*, July 29) has an importance which transcends the intrinsic interest of any individual object likely to be obtained there.

In the present instance, there is added its bearing on the site of Skara Brae, the similar village discovered and excavated some ten years ago, of which the significance for our knowledge of stone age culture and more of life was such that Prof. V. Gordon Childe at the time described it as a veritable Knossos of the north. The new site defines more nearly the dating of the culture, left somewhat indeterminate, at Skara Brae. The discovery of a portion of a beaker, in association with objects of the Skara Brae type, fixes the period of occupation at somewhere about the transition from stone to bronze in Great Britain, that is at about 1500 B.C. Further the Rinyo village, being apparently complete, should supply details which at Skara Brae had been swept away by the encroachments of the sea on the sand dunes. The Rinyo settlement has been excavated by Mr. Walter W. Grant, with whom has been associated Prof. Gordon Childe. Below the floor in which the beaker fragment was discovered, traces of earlier occupation have been found. These are in the form of commodious stone houses, provided with recesses for beds, built dressers and even a system of drainage. In addition to open hearths, some of the houses have clay ovens, a novel feature. It is anticipated that eventually excavation will give a complete picture of a whole stone age settlement, unique in Britain, and indeed in western Europe, and at the same time throw a new light on the social organization and economy of a neolithic community.

### Rhodesian National Museum

In reference to the announcement of the proposed National Museum for Southern Rhodesia in the neighbourhood of the Zimbabwe ruins (see NATURE, July 9, p. 65), Mr. F. M. Collins writes to suggest the possibility of a confusion between the Victoria Falls and Fort Victoria, the township one hundred and eighty miles east of Buluwayo, near which the ruins are situated, while their distance from the Falls is by air approximately four hundred miles. 'Proximity', however, the term in the comment in these columns to which Mr. Collins takes exception, is, as he admits, relative, and as the general sense indicated was used in comparison with, for example, the distance from Cape Town, which would affect students and tourists, rather than in relation to absolute mileage.

### Science and the Way to Peace

An "Appeal to the Scientists of the World" has reached us from India. The author, Dr. Bhagavan Das of Benares, a member of the Legislative Assembly of India, refers to the imminent peril of another world war, far surpassing the last in horror and destructiveness, and the frightful strain meanwhile imposed on mankind by preparation for defence. He seeks to show that a heavy responsibility for this state of affairs rests on the learned world as a whole, partly because modern warfare owes its peculiarly devastating character to scientific research and the collaboration of men of science with the organizers of war and partly because the ideas that motivate wars are products of the speculations of philosophers and the vulgarization and misapplication of theories invented by men of science, notably that of the ascent of man through the struggle for existence and survival of the fittest. He quotes from the records of ancient Aryan wisdom: "Science (Vidya) came to the man of wisdom, the man of knowledge and purity, and said to him: guard me as a sacred trust; give me not to the wicked and sinful, but only to the pure of heart and large of mind; so only will I be strong to nourish mankind; otherwise I will only destroy thee and thy pupils and thy people." So in our own day Alexis Carrel in "Man the Unknown" writes: "The environment which science and technology have succeeded in developing for man does not suit him because it has been constructed at random without regard for his true self." Therefore, the appeal says, it is "up to" the learned world to get together and do something about it. Peradventure where politicians have failed men of science may find a way of approach to disarmament, military and economic.

### The Ontario Research Foundation

The report of the Ontario Research Foundation for 1937 (Sessional Paper, No. 52. Pp. 35. Toronto: King's Printer) refers to an increase in the amount of research work carried out in contact and in co-operation with industrial companies, the revenue received for services rendered to industry itself having increased by thirty per cent. The Textiles Department has during the year developed a launderometer for determining the fastness of dyed goods to washing, a fadeometer for determining the fastness of coloured fabrics to light, a crock-meter for determining fastness of dyes to rubbing, and an autographic tensile strength and elongation tester for determining the strength, extensibility and yarn slippage of materials. The Engineering and Metallurgy Department continued its investigation on summer comfort standards for the Toronto district and also its study of the resistance to abrasion of iron and steel balls under the conditions existing in the grinding mills of mines. In the Department of Chemistry, the development of a laboratory for the study of problems relating to paper, printing and adhesives has been completed. Work on the transfer of pigments from aqueous pastes to an oily medium by methods which are commercially feasible has reached its final stages and in addition to the mechanical problem an emulsifying agent is required which is not detrimental to the final product. The equipment and organization of a laboratory for the study of plastics has been commenced, and a new laboratory has also been inaugurated to study problems associated with the manufacture of waxed paper and similar products. The Department of Biochemistry has continued its investigations on a combined system of tannage for sole and belting leather and on problems connected with the Matzka process for the preparation of fruit juices which are stable for prolonged periods and retain their original flavour and content of vitamins. Investigations carried out by the Department of Agriculture have

related to mineral deficiencies of land types and the relation between soil, climate and cultivation of the principal crops in Ontario, while the Department of Pathology and Bacteriology has continued its studies of bovine mastitis and the parasites of sheep.

### The Carnegie Institution of Washington

THE Yearbook of the Carnegie Institution of Washington, July 1, 1936–June 30, 1937, contains the reports of the Executive Committee and of the president for the year ended October 31, 1937, together with reports on investigations received up to December 10 and a bibliography of publications issued during the year by the Institution or of the Institution's staff through all channels (Washington : Carnegie Institution of Washington). The president's report again refers to the relations between science and social problems and to the importance in society not merely to appreciate the difficulties in interpretation of the influence of science but also to be aware of the interdependence among social elements in the same way that we are aware of the interrelations among elements involved in the unity of Nature. The Geophysical Laboratory has continued researches to determine with all possible precision the underlying causes of geological and geophysical phenomena. A major advance in the terrestrial-magnetic research is reported by Dr. J. A. Fleming, in the proof of the association of a special type of magnetic disturbance and sharp fade-outs of high-frequency radio-wave reflections with bright eruptions in the solar chromosphere. With this advance, the Mount Wilson Observatory was also associated, and the Observatory also expanded greatly the scope of solar investigations with the rapid increase in solar activity. The Division of Plant Biology has continued to study the ecology of the Great Plains and its bearing on the agricultural and human population of that area. The Division of Animal Biology has made several observations fundamental to the cancer problem, and the value of diverse approaches by different groups of workers is well illustrated in this work as in reports from the Divisions of Embryology, the Nutrition Laboratory and the Department of Genetics in the field of endocrinology.

### Technical Colleges of South Africa

THE Carnegie Corporation of New York has lately issued a critical study by Dr. F. H. Spencer of the technical colleges of South Africa. Dr. Spencer has had experience of technical education in Great Britain, and this has enabled him to make some interesting comparisons. The technical colleges provide (*a*) full-time pre-apprenticeship courses for pupils aged 14–17 or 18, (*b*) part-time courses for apprentices and others already at work. The place accorded in the full-time courses to general cultural work is, by British standards, inadequate, geography being dropped after the first year, while history, even from the economic point of view, does not enter the picture. The part-time courses, which are everywhere the largest part of the technical college work, are dominated by the Apprenticeship Law. This enactment has conferred on South Africa some of the benefits which in Great Britain should have resulted from the clauses of the Fisher Act providing for daytime continuation education from 14 to 18. In South Africa, despite a certain amount of recalcitrance, the Apprentice Law is an undoubted success. Apprentices attend ordinarily about eight hours a week of which half is taken from day-time working hours. The great merit of the system is that the compulsory attendance is almost universally followed up to an advanced stage by a not unsatisfactory proportion of the apprentices. This advanced stage, at least for the constructional trades, is comparable with university work, and those who pass through it to the national certificate stage "will furnish the 'non-commissioned' staff of industry who are as essential to success as the management".

### The Belgian Grid

IN *Electrical Industries* of July, W. Fennell gives a review of the salient engineering features of the Belgian Grid, which began by the co-operation in 1919 of isolated supply companies. These companies, mostly in the southern and eastern provinces (Liège, etc.), happened to be in close contact with heavy industries. They realized the existence of by-product power 'going to waste' at the large industrial works and saw that in some cases it would be economical to use this power rather than to build large power stations or extend small ones. A power production combine was formed to further the interests of manufacturers who had blast furnace and coke oven gas and process steam available greatly in excess of their own power requirements. In addition, they had engines used as stand-by plant, much of which would not be necessary if the various works' plants were interconnected. The electricity supply companies also had means of utilizing the waste power. This combine has spread so that it includes practically the whole country under a grouping system. All the undertakings and associated works are linked up into two networks, north and south, which are themselves interconnected. The production of power, while remaining under local control, is directed by a national co-ordinating company. The tariff applied to plant owners is based on the principle that the amounts they pay or receive are equal to the reduction or increase of expenditure entailed in their installations by running in parallel, compared with independent working. The success that Belgium has attained as a competitor in the steel and chemical industries indicates that this co-operative experiment, now twenty years old, has been a substantial contributory cause.

### Conservation of Natural Resources

UNDER this title, the American Association for the Advancement of Science has issued a selected list of literature dealing with various aspects of the subject. Almost too late, rather than too soon, the United States is becoming conscious of the significance of the vast subject of conservation. The very word is itself

indicative of a more sober outlook. The falsely alluring concept of limitlessness which in the last century tempted Americans to embark on a policy of exploitation concurrently with expansion has gone; in certain spheres retreat has followed expansion and many rueful surveys are being made of what has been left, with sound suggestions as to how it may best be used for the future. America wants to reverse the processes by which "man has violated basic arrangements in a manner which Nature will not tolerate". The literature covers a wide range of subjects, including land use, which in this continent is especially bound up with the subject of soil erosion; forestry and afforestation, important not merely because "almost every one of the forty-eight states is headed towards forest bankruptcy in timber" but also because deforestation has had a terrible sequel in floods, soil wastage and silted rivers. Lists of books on "Oil and Gas Conservation" and "Saving Our minerals" indicate that the future shortage of these vital products has passed from the realm of prophecy to that of serious and calculable prediction. The inclusion of a section on the conservation of wild life serves to show how important is this question, both in and out of the national parks which are of increasing value to the States.

## Research at Port Erin, Isle of Man

THE report of 1937 (No. 50) of the Marine Biological Station at Port Erin, Isle of Man, drawn up by Dr. R. J. Daniel, director, shows the largest number of students using the building in any one year and also the greatest number of visitors to the aquarium. More plaice larvæ have been liberated than during any previous season and there has been the highest percentage survival of lobsterlings in the hatchery. The new Fauna List is now published—a most useful and complete volume—which will be of the greatest assistance to all students. The main work of the Laboratory has been directed towards the breeding of oysters, a research which has now been going on for more than three years. The chief difficulty in obtaining proper spatfalls in the experimental pond is the varying temperature—a very low temperature ruining a promising beginning. To combat such conditions, a number of oysters were kept at a raised temperature-level in the culture house. Some oysters were also kept in dishes in the hatchery and the spawn from these has provided the basis for the limited series of culture-house experiments. These are still going on, and work is maintained in the improvement of methods and feeding of the larvæ in specially adapted vessels.

## Announcements

SIR WILLIAM BRAGG has been elected a foreign associate of the Paris Academy of Sciences in succession to the late L. Torres Quevedo.

PROF. MAJOR GREENWOOD, professor of epidemiology and vital statistics in the University of London, has been awarded the Bisset Hawkins Gold Medal of the Royal College of Physicians, for his researches in statistics.

THE twelfth International Horticultural Congress will be held in Berlin on August 12–20. After a series of meetings in Berlin, the delegates will visit certain horticultural experimental stations and the chief areas of horticultural production. A visit on August 20 to a Horticultural Exhibition at Essen will bring the Congress to an end. The following delegation has been chosen to represent the British Government at the Congress: Mr. H. V. Taylor, Mr. David Akenhead, Prof. E. E. Cheeseman, Mr. F. Birkinshaw, Mr. F. J. Chittenden, Col. F. R. Durham, Dr. R. G. Hatton, Sir Arthur Hill, Mr. H. J. Holman, Sir Frank Stockdale, Dr. M. A. H. Tincker and Dr. C. W. Wardlaw.

A General Discussion on Luminescence has been arranged by the Faraday Society, and will be held in the Biochemical Laboratory, University of Oxford, on September 15–17. Among the topics to be discussed are various aspects of the luminescence of solids, liquids and gases, and chemiluminescence. As usual in these discussions, a number of distinguished foreign guests have been invited to take part.

THE Council of the Harveian Society of London has chosen "The Value of Periodic Medical Examination in the Detection of Disease in Middle Life" as the subject for the Buxton Browne Prize, which consists of a medal and a sum of £100. The prize is open to any member of the medical profession registered in the British Isles or Dominions, and is limited to candidates less than forty-five years of age. Essays must be sent to the Treasurer of the Society, Mr. Cecil Wakeley, 14 Devonshire Street, W.1, before October 1, 1939.

MR. ROBERT L. SACKETT, dean of the School of Engineering at Pennsylvania State College from 1915 until 1937, has been awarded the Lamme Medal of the Society for the Promotion of Engineering Education for achievement in this technical field. Mr. Sackett is the eleventh recipient of the medal provided for in a trust fund created by the late Benjamin Garver Lamme, who was chief engineer of the Westinghouse Electric and Manufacturing Co. for twenty-one years prior to his death in 1924. Since his retirement as dean at Pennsylvania State College, Mr. Sackett has devoted himself largely to the work of the Engineering Council for Professional Development. He has served as president of the Society for the Promotion of Engineering Education and as vice-president of the American Society of Mechanical Engineers.

ERRATUM. In the letter entitled "Irregular Mitosis and Meiosis induced by Acenaphthene" by Prof. Dontcho Kostoff, in NATURE of June 25, p. 1144, the sentence beginning "The viable pollen grains are equal in size . . ." should read "The viable pollen grains are unequal in size. . . ."

# Letters to the Editor

*The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 258.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

## Optical Observation of the Debye Heat Waves in Crystals

MANY years ago[1], it was pointed out by one of us that Debye's concept identifying the thermal energy of a solid with the energy of elastic vibrations within it having a wide range of frequencies has an important optical consequence, namely, that a beam of light traversing a transparent solid would be scattered to an extent depending upon the energy of thermal agitation. This conclusion was also verified experimentally in a semi-quantitative fashion[2]. The principal experimental difficulty in studying the subject was that of obtaining crystals sufficiently large and at the same time free from imperfections or inclusions, these conditions being necessary to prevent the feeble thermal opalescence being overpowered by parasitic diffuse light. The same difficulty appears in attempting to investigate the thermal opalescence in crystals by spectroscopic methods. The elastic waves, longitudinal or transverse as the case may be, which scatter the light being progressive, they should give rise to Brillouin-Doppler shifts of optical frequency corresponding to their respective acoustic velocities. If parasitic light be present, the unmodified scattering and the hyperfine structure components usually accompanying the same would overpower the Brillouin-Doppler components to be expected.

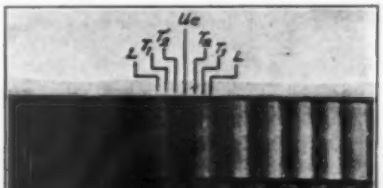



Fig. 1.
(*a*) DIRECT LIGHT; (*b*) SCATTERED LIGHT.

It is significant, in view of the foregoing remarks, that E. Gross[3], who claimed, some years ago, to have obtained evidence of a Doppler shift due to the longitudinal waves in crystals, offered neither photographs nor measurements confirmatory of the claim. Even in a recent communication[4] in which the same author points out that with crystals there should be three components on either side in the scattered light corresponding to the three sheets of the acoustic wave-surface, no such convincing experimental evidence has been presented. Indeed, a perusal of the communications quoted leaves the impression that the results so far obtained by E. Gross suggest, rather than demonstrate, the existence of such Brillouin-Doppler shifts in the light scattered by crystals.

The thermal scattering of light in crystals has been under investigation in this laboratory during the past few years, and we have at last succeeded in obtaining satisfactory photographs which show in an unmistakable way the physical reality of the Debye heat waves in crystals. Fig. 1 (*a*) shows the interference pattern taken with a Lummer Gehrcke plate of 4046 A. radiation of a water-cooled mercury lamp. Fig. 1 (*b*) shows the pattern, under exactly the same conditions, of this radiation scattered transversely within a large crystal of gypsum. The latter had been previously examined in a strong beam of sunlight, and a portion which showed a clear blue thermal opalescence and was free from inclusions was chosen for illumination. On a comparison of the two pictures which have been carefully set side by side to correspond, it will be seen that the two patterns are completely different. Measurements show that the principal component of the incident radiation, which is very feebly present in the scattered light, gives rise to three components on either side displaced by 0·59, 0·36 and 0·2 cm.$^{-1}$ of which the first is the most intense. From the Brillouin formula, these three shifts correspond respectively to acoustic velocities 3,350, 2,050 and 1,100 metres per second. Of these, the first is presumably due to the longitudinal waves and the other two due to the transverse ones.

C. V. RAMAN.
C. S. VENKATESWARAN.

Department of Physics,
Indian Institute of Science,
Bangalore.
July 8.

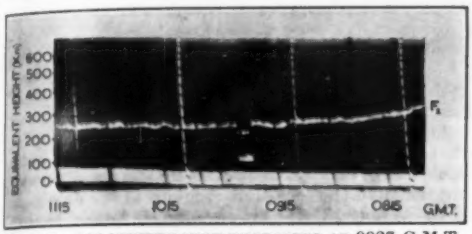
[1] Raman, C. V., NATURE, **109**, 42 (1922).
[2] Raman, C. V., NATURE, **111**, 13 (1923).
[3] Gross, E., NATURE, **136**, 211 (1930); and *Z. Phys.*, **63**, 685 (1932).
[4] Gross, E., *C.R.*, U.R.S.S., **18**, 93 (1938).

## Bright Solar Eruptions and the Ionosphere

AN investigation of the ionospheric conditions during a bright solar eruption shows that at such times an increase of ionization can be produced within the normally reflecting regions of the ionosphere.

The accompanying photograph shows such an increase of ionization to have occurred quite suddenly at 0927 G.M.T. on October 1, 1937, at an equivalent height of 125 km., or slightly higher than the normal *E* region. A solar eruption of intensity 1 reported

from the Royal Observatory, Greenwich, to have begun at 0928 G.M.T. was, we suggest, the cause of this burst of ionization, which increased the normal amount in this region by more than 100 per cent. The photograph shows a second reflection from this height of 125 km., indicating that no marked absorption in or below the normal *E* region was produced during the eruption. These observations indicate that the quality of the ionosphere for the propagation of radio waves is sometimes improved as the result of a bright solar eruption.




IONOSPHERIC DISTURBANCE BEGINNING AT 0927$_5$ G.M.T. ON OCTOBER 1, 1937.

It is now well known[1] that there have been an increasing number of occasions during the last few years when, during a bright solar eruption, radio signals have disappeared completely. At such times, the condition of the ionosphere is similar to that described in 1933[2] as the 'no-echo' condition, and is due to the production of ionization at abnormally low levels, the consequent absorption thereby masking the normal reflecting regions.

We deduce therefore that on a majority of occasions on which bright solar eruptions take place, ionization is produced in the ionosphere, and that it depends primarily upon the *height* at which it is produced whether radio transmission conditions are better or worse. It follows therefore that the initial comparisons of the worst radio transmission conditions and bright solar eruptions must be extended to include this more recent observation before the effects of a bright solar eruption on the ionosphere can be completely assessed.

The work described above was carried out as part of the programme of the Radio Research Board and this note is published by permission of the Department of Scientific and Industrial Research.

R. NAISMITH.
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July 7.

[1] For bibliography, see Newton and Barton, *Mon. Not. Roy. Ast. Soc.*, 594 (June 1937).
[2] Appleton, Naismith and Builder, NATURE, **132**, 341 (1933).

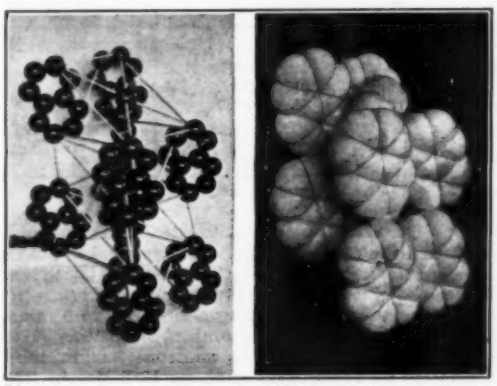
## Crystal Structure Models

TABLE tennis balls have often been used in making models of crystal structures, and the purpose of this letter is to direct attention to two ways of using them which, so far as we are aware, are new.

(1) Models of crystal structures of inorganic substances are clearest when the atomic centres are indicated by balls and these are joined by rods. The following method may be used to connect table tennis balls by rods of celluloid, a convenient diameter for which has been found to be 3/16 in. The ends of the rod are dipped in acetone for about a minute when they swell and become gelatinous on the surface. Meanwhile, the surfaces of the balls to be joined are rendered slightly gelatinous by moistening them with acetone. The rod is now placed in position between the balls and, if necessary, held there for about 20 sec. The rod and balls now adhere to one another sufficiently strongly for it to be possible to continue building the model. 'Durofix' may be used as the cement, but the join is not so strong as that obtained with acetone. Celluloid rods can be easily cut to any required length and this greatly facilitates the making of models with correct interatomic distances.

(2) In studying the structures of organic substances, it is often necessary to see how molecules pack into the unit cell. The distance between neighbouring carbon atoms in a molecule is about 1·5 A., while the distance between carbon atoms in neighbouring molecules is not usually less than 3·4 A. A model representing the space occupied by any one molecule can therefore be made by cutting off spherical caps from the table tennis balls and fitting the balls together so that the distance between their centres is $\frac{3}{4}$ in. Such model molecules can then be packed into the unit cell with their surfaces touching. To cut off the spherical caps the balls are held in a split brass tube of internal diameter slightly less than $1\frac{1}{4}$ in., mounted on a lathe, and a razor blade is used as a cutting tool.

The accompanying photographs show similarly orientated models of naphthalene, $C_{10}H_{14}$, constructed according to both methods. The model with rods



MODELS OF NAPHTHALENE BUILT UP FROM TABLE TENNIS BALLS AND CELLULOID RODS (LEFT), AND FROM TABLE TENNIS BALLS ALONE (RIGHT), ILLUSTRATING THE INTERATOMIC DISTANCES AND MOLECULAR PACKING RESPECTIVELY.

is valuable in teaching, and the packing model is more useful in research work when it is required to discover the geometrically possible molecular orientations.

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G. KNOTT.

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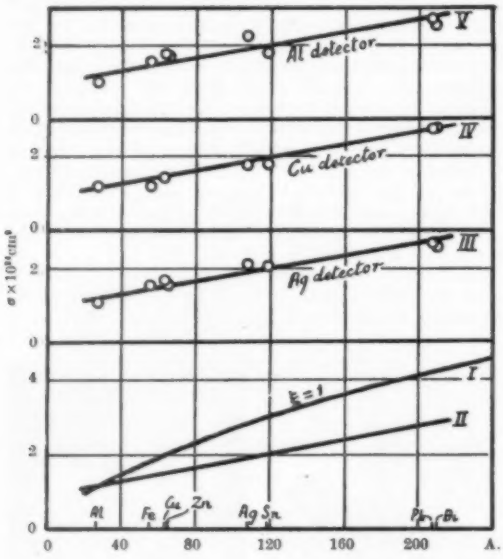
## Interaction of Fast Neutrons with Atomic Nuclei

Neutrons may interact with nuclei in two different ways, namely: (*a*) formation of a compound nucleus, in a quasi-stationary state, with a subsequent emission of a corpuscular or electromagnetic radiation; (*b*) elastic (possibly also inelastic) collisions without sticking to the nucleus.

The decrease of intensity of a fast neutron beam when passing through matter, measured with a detector which responds only to neutrons above a certain energy, will be due to inelastic collisions (mostly process *a*) and elastic scattering (mostly process *b*).

The aim of this work was the study of the interaction of fast neutrons with nuclei through the measurement of the neutron absorption in different substances.




I produced the neutrons by deuteron bombardment of lithium (400 kv., about 100 μ amp.); as a measure of their intensity I used the activities induced by reactions of the type $(n, 2n)$ and $(n, p)$, that is, such reactions as $^{107}$Ag-$n$-$2n$-$^{106}$Ag (24·5 min.), $^{63}$Cu-$n$-$2n$-$^{62}$Cu (10·5 min.) and $^{27}$Al-$n$-$p$-$^{27}$Mg (10·2 min.). The energy of the neutrons has in these conditions an upper limit of about 13·5 Mev.[1]. The detectors respond only to high-speed neutrons: silver and copper to neutrons of energies certainly above 8 Mev. and probably practically 12 Mev. (at least for copper[2]), aluminium above 4·5 Mev. Thus my measurements concern two energy regions of very different widths: 12–13·5 Mev. and 4·5–13·5 Mev.

The absorbing substances and the detectors were placed in the immediate neighbourhood of the neutron source; thus a great part of the scattered neutrons were reaching the detector and therefore the extinction of the beam was mostly due to effects other than scattering. If we suppose that every neutron that sticks to a nucleus and forms with it a compound nucleus cannot produce any of the above-mentioned reactions in the detector, then, in these conditions, the effective cross-section of the absorbing nucleus, as calculated from the intensity measurements, should not be smaller than $\sigma = \pi R^2 \xi$ where $\xi$ is the sticking probability (process *a*) and $R$ the nuclear radius. Curve I gives the calculated values of $\sigma$ for different atomic weights $A$, assuming $\xi = 1$ and $R = 2 \times 10^{-13} A^{1/3}$ cm.

Measured cross-sections for silver, copper and aluminium detectors are plotted as Curves III, IV, V, and the average for all detectors as Curve II.

The discrepancy for heavy nuclei between the experimental Curve II and the theoretical Curve I can be explained by assuming that for these nuclei, $\xi$ is less than 1, that is, a fast neutron may fall on a nucleus without sticking to it and without changing its direction by a great amount.

Another possible explanation would be to suppose that $\xi$ equals 1, but to assume that compound nuclei are able to emit neutrons still of sufficient energy to activate the detectors; in this case we should be dealing either with elastic scattering or with scattering in which the neutron suffers quite a small loss of energy. However, due to the difference in the width of the sensitivity regions of the detectors, it is to be noted that this assumption would lead to a greater cross-section as detected with silver and copper than with aluminium. This is not the case and, on the other hand, an emission of very fast neutrons by compound nuclei, though highly excited, is very improbable, if we assume the liquid drop model.

The former assumption ($\xi$ less than 1) seems to fit experimental data and theoretical expectations better. It is interesting to note that the experiments of Dunning, Pegram, Fink and Mitchell[3] in which, contrary to my experimental conditions, the authors measured the absorption including all processes mentioned above (*a* and *b*) the curve $\sigma(A)$ has a shape corresponding rather to the assumption that $\xi$ equals 1.

After this work was completed, Grahame and Seaborg[4] published a paper on a similar subject. My results, though concerning neutrons of somewhat different energy regions, are in excellent agreement with theirs.

A detailed description of the apparatus and the experimental arrangement used will be published elsewhere.

I wish to express my thanks to Prof. S. Pieńkowski for many stimulating discussions.

A. SOŁTAN.

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University, Warsaw.

[1] Stephens, W. E., *Phys. Rev.*, **53**, 223 (1938).
[2] Sagane, R., *Phys. Rev.*, **53**, 212 (1938).
[3] Dunning, J. R., Pegram, G. B., Fink, G. A., and Mitchell, D. P., *Phys. Rev.*, **48**, 265 (1935).
[4] Grahame, D. C., and Seaborg, G. T., *Phys. Rev.*, **53**, 795 (1938).

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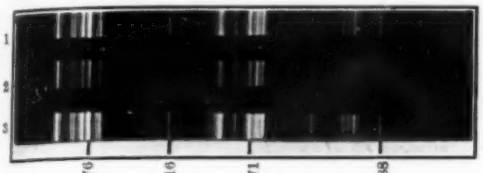
## Band Spectrum of Helium

IN the course of some investigations on the electrical properties of helium at fairly high pressures (about 25 mm. mercury), it was found that, if the gas was excited in such a way as to produce the line spectrum and the band spectrum of helium in comparable intensity, the rate of decrease in intensity of the band spectrum was much smaller than that of the line spectrum after the excitation was removed.

The accompanying reproduction shows three spectra of a discharge in helium at 27·5 mm. pressure taken under different conditions with a Bellingham and Stanley No. 2 glass spectrograph. Spectrum 1

was taken when the discharge was running continuously. Spectrum 2 was taken of a discharge in which the excitation was interrupted periodically and in which the light from the discharge could fall on the spectrograph about 1/600 sec. after the excitation was interrupted. Spectrum 3 was taken with an interrupted discharge in which the light from the discharge was able to fall on the spectrograph just before the excitation was interrupted.




BAND SPECTRUM OF HELIUM (27·5 MM. MERCURY).

It will be seen that, for comparable intensities of these band spectra, the intensity of the lines in spectrum 2 is negligible compared with that of the lines in the spectra 1 and 3. As the energy of the electrons in the discharge is insufficient, 1/600 sec. after the discharge has been interrupted, to excite the atoms of helium, it seems necessary to suppose either that the helium molecule is formed after interruption of the discharge by the collision of a metastable atom with a neutral atom, or that the helium molecules formed in the discharge have a life of the order of 1/600 sec. As the rate of decrease in intensity of the band spectrum is of the same order as the rate of decrease in number of metastable atoms, the former explanation seems the more probable.

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M. S. WILLS.

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May 19.

## Reflecting Power of Crystals with an Ideal Mosaic

WE have studied photographically the connexion between the magnitude of the mosaic structure of crystals, $\Delta\sigma$, and the intensity of X-ray reflection, $R_s$, in a symmetrical arrangement, in which the radiation by the mosaic crystals is focused[1].

As has been shown by Feifer and Jahoda by means of a double crystal spectrometer with photographic recording[2], there are two kinds of mosaic, namely, a normal regular 'ideal mosaic' ($\Delta\sigma_{min.}$) and a coarse, less regular, the latter occurring in imperfect and especially in metallic crystals. This irregular mosaic causes sometimes a considerable increase of the value of $\Delta\sigma_{min.}$.

The experiments have shown that the reflecting power of X-rays varies with the magnitude of the mosaic $\Delta\sigma_{min.}$, and that in the case of crystals with a large ideal mosaic, its influence on the intensity of reflection $R_s$ predominates over the other factors (distribution of electrons, absorption in the lattice and so on). The following relation has been found to hold:

$$\frac{f(\Delta\sigma_{min.})}{R_s} = \text{constant}.$$

When investigating the reflecting planes of crystals by Bačkovský's method, it is found that separate parts of the crystal are considerably imperfect, whereas some parts do not reflect at all. Thus an exact relationship can only be obtained by the use of especially selected crystals. As an example of our measurements with different crystals—quartz, gypsum, rock salt and sphalerite—we have discussed measurements in which the coefficient of reflection is characterized by the exposure $T_s \sim 1/R_s$ (in a symmetrical arrangement for the copper $K$ lines) under identical conditions.

| Crystal | $\Delta\sigma_{min.} \times 10^5$ (rad.) | $T_s \times 10^{-3}$ (sec.) | $\Delta\sigma_{min.} \times T_s \times 10^4 \sim \frac{\Delta\sigma_{min.}}{R}$ |
|---|---|---|---|
| $SiO_2 \perp$ el. axis | (4·8) | {36·0} {70·0} | {1·7} {3·3} |
| $CaSO_4$ | 10·4 | 22·4 | 2·3 |
| NaCl | 28·8 | 7·0 | 2·0 |
| ZnS | 56·2 | 3·6 | 2·0 |

From the third column of the table, it is evident that the product of the exposure and the magnitude of the ideal mosaic is constant, that is,

$$T_s \cdot \Delta\sigma_{min.} = \text{constant}.$$

Only in the case of quartz, where the mosaic is insignificant, do the results fluctuate. The coarse mosaic of the imperfect crystals of metallic type does not contribute to the intensity of reflection.

We wish to mention that under the influence of a direct electric field (of about 10,000 volts/cm.) we obtained for ZnS a diminution of the mosaic $\Delta\sigma_{min.}$ from 110″ to 80″. This change became, after a longer application of tension, permanent (plastic). The diminution of the mosaic was accompanied by the diminution of the intensity of reflection. Since in the case of rock salt no analogous case was observed, the rectification of the mosaic of sphalerite is probably due to the piezo-electric forces.

The changes in the mosaic exhibited by grinding depend mainly on the kind of grinding.

The large intensity of reflection of crystals with an ideal mosaic justifies their utilization in all symmetrical methods.

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Spectroscopic Institute,
Charles University,
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July 1.

[1] Bačkovský, J. M., NATURE, 141, 872 (1938).
[2] Feifer, J., and Jahoda, M., *C.R. Acad. Sci.*, in the press.

## Films on Freshly Abraded Copper Surfaces

WE have been interested in the nature and amount of films formed on metals during and immediately after cleaning by abrasion, and have made measurements of the thickness of such films using a modification of the electrolytic method of Evans and Miley[1]. We find that films of substantially the same thickness, giving similar cathode potential time curves at constant current, are present on freshly abraded copper whether the abrasion is carried out in air or under benzene. A somewhat thinner film was found when an abrasive wet with water was used. The results are summarized in the accompanying table, the figures in the third and fourth columns representing the means of at least three determinations for experiments 1–3 and of two determinations for

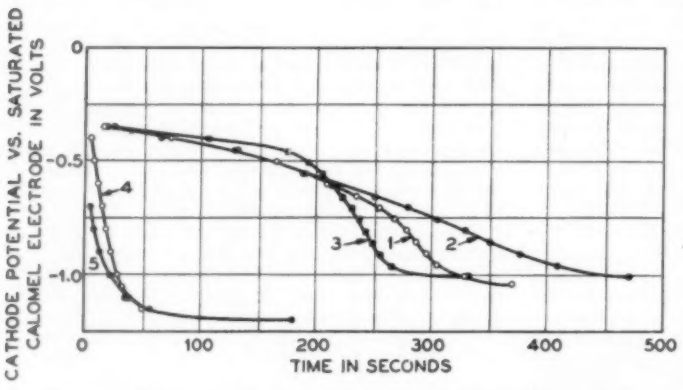
experiments 4 and 5. Typical curves are given in the accompanying figure.

THICKNESS OF FILMS ON FRESHLY ABRADED COPPER SURFACES.

| Experiment No. | Treatment of surface | Milli-equivalents of film reduced* per sq. cm. × $10^3$ | Thickness of film as $Cu_2O$*(A.) |
|---|---|---|---|
| 1 | Abraded 000 emery paper under benzene | 3·2 | 41 |
| 2 | Abraded 000 emery paper in air .. | 3·9 | 47 |
| 3 | Abraded 000 emery powder under water | 2·8 | 33 |
| 4 | Abraded 000 emery paper, reduced in hydrogen .. .. | No detectable film | |
| 5 | Abraded 000 emery paper, reduced in hydrogen, immersed in benzene 20 mins. | 0·16 | 2 |

* Area of surface calculated from measured dimensions.

The edges and both faces of the specimens, which were milled to 2 cm. × 2 cm. × 0·2 cm. from oxygen-free high-conductivity copper, were abraded. Abrasion under benzene was carried out in a very similar manner to that described by Dobinski[2]. The benzene was a high-quality thiophene-free grade which had been twice redistilled over activated copper. The specimens were placed wet in the electrolytic cell




CATHODE REDUCTION OF FILMS ON FRESHLY ABRADED COPPER.

Current density, 0·01 ma./sq. cm.; area of surface, 9·6 sq. cm. Arrows indicate inflection point. Numbers refer to accompanying table.

and were dried in a stream of purified nitrogen. The cathode potential measurements were made in an oxygen-free solution over which nitrogen was passed.

Recently Dobinski[2] has shown that the electron diffraction pattern obtained for a metal polished under benzene is different from that for a metal polished in air, and has inferred that the pattern is characteristic of an unoxidized surface. The experiments reported here show that abrasion of copper surfaces under benzene by a very similar technique produces a surface film, probably oxide, which is comparable in thickness to that produced by abrasion in air. Submersion of copper in benzene without abrasion produces a considerably thinner film. Dobinski assumes that polishing under benzene means polishing in the absence of air. Actually the solubility of oxygen in benzene is appreciable[3]. He also believes that polishing with a moist abrasive in air produces a thicker film than polishing with a dry abrasive. Our experiments indicate that this is not the case when copper is abraded with emery.

Our results may be explained on the assumption that combination of the copper takes place with oxygen dissolved in the benzene or the water at the high local transient temperatures developed on the surface during abrasion[4]. More detailed results and experimental technique will be published shortly.

Bell Telephone Laboratories, 463, West Street, New York. June 14.

W. E. CAMPBELL.
U. B. THOMAS.

[1] Evans and Miley, NATURE, **139**, 283 (1937); Miley Carnegie Scholarship Memoirs, **25**, 197 (1936); *J. Amer. Chem. Soc.*, **59**, 2626 (1937).

[2] Dobinski, NATURE, **138**, 31 (1936); *Phil. Mag.*, Ser. 7, **23**, 397 (1937).

[3] Bowden and Ridler, *Proc. Roy. Soc.*, A, **104**, 640 (1936); Bowden and Hughes, NATURE, **139**, 152 (1937); *Proc. Roy. Soc.*, A, **160**, 575 (1937).

[4] "Inter. Crit. Tables", **3**, pp. 263, 255. The Bunsen absorption coefficients for oxygen in benzene and water are 0·163 and 0·031, respectively.

## Electron-Inertia Effects in Thermionic Tubes

I WAS extremely interested in the communication by Messrs. Ratcliffe and Kownacki[1] on the investigation of electron-inertia effects in thermionic tubes. As these writers state, the difficulty in the experimental determination of inertia effects in ordinary valves is that they occur at such high frequencies that accurate measurement is practically impossible. In order to increase the inter-electrode transit time and so decrease the frequency at which the inertia effects become appreciable, Messrs. Ratcliffe and Kownacki propose using a thermionic tube in which the electrons are replaced by relatively slowly moving ions.

I have described[2] an alternative way by which the inertia effects may be made to occur at sufficiently low frequencies for accurate measurement. The inter-electrode transit time of electrons in a cylindrical diode can be increased many times if a magnetic field of suitable magnitude is applied to the valve in the direction of the electrode axis. I have investigated experimentally the effect of these long transit times and have determined the equivalent electrical circuit of any thermionic tube in which the inter-electrode transit time of electrons is predominant. I have shown that the long transit times possible in magnetrons are responsible for the production in these valves of relatively low-frequency oscillations similar in character to the high-frequency Barkhausen-Kurz oscillations generated in positive-grid triodes. It would be interesting to know whether Messrs. Ratcliffe and Kownacki obtain the same results for inertia-effect with their novel type of triode as I have with the magnetron.

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Radio Department,
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June 24.

[1] NATURE, **141**, 1009 (1938).

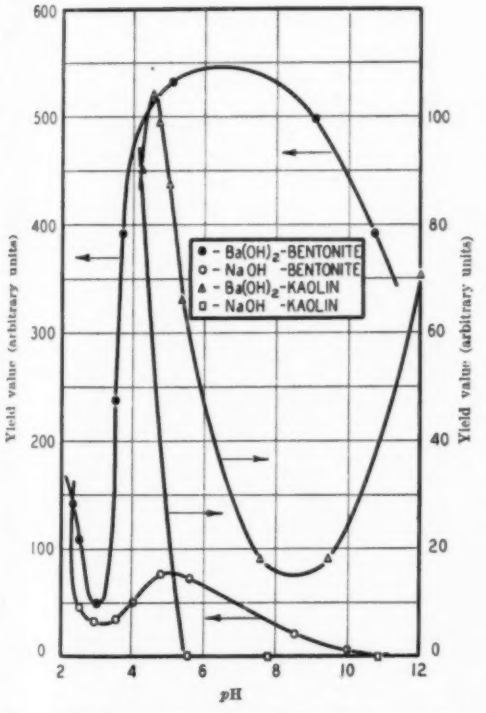
[2] *J. Inst. Elect. Eng.*, **80**, 84–97 (1937).

## Viscosity of Clay Suspensions

CONSIDERABLE attention has been given recently to the thixotropy and viscosity characteristics of clays. During the course of a research programme now in progress, certain results of general interest have been obtained.

| Fract. No. | Average equivalent spherical diameter | Mobility 25° C. | $(cp^{-1}$ 50° C.) | Yield Value (dynes/cm.²) 25° C. | 50° C. | r (25° C.) |
|---|---|---|---|---|---|---|
| 1 | 0·135 μ | 0·580 | — | 34·5 | — | 1·93 |
| 2 | 0·28 | 0·625 | 1·64 | 22·6 | 32·0 | 1·79 |
| 3 | 0·45 | 0·862 | — | 0 | — | 1·30 |
| 4 | 1·05 | 0·950 | — | 0 | — | 1·18 |
| 5 | 0·55 | 0·950 | — | 0 | — | 1·18 |
| 6 | 2·2 | 0·991 | 2·94 | 0 | 0 | 1·13 |
| 7 | 8·5 | 0·991 | — | 0 | — | 1·13 |
| 2 (in 40·2 wt. % ethyl alcohol | 0·28 | 0·276 | 2·14 | 69·5 | 48 | 1·52 |

Viscosity measurements, using a capillary viscosimeter (radius 0·0415 cm., length 9·33 cm.) were made upon seven samples of kaolinite of varying particle size, kindly supplied by Dr. H. Whittaker from fractionation of Kentucky ball clay (fractions 1–4) and Georgia kaolin (fractions 5–7). X-ray analysis indicated all to be essentially kaolinite, except fraction 4, which contained about 30 per cent silica. The results for suspensions of 10 weight per cent are shown in the accompanying table, *p*H being approximately constant at 6·5.




Deviation from normal behaviour, as indicated by yield value and relative viscosity at infinite shear, increases with decreasing particle size and was found to parallel plasticity. Rise in temperature caused an increase of yield value for aqueous suspensions, in contradiction of predictions[1] made on the basis of the attraction-repulsive force theory of Hamaker[2]. Alcoholic dispersions, however, showed a diminution in yield value with temperature, as did glass spheres suspended in an organic liquid and measured by a technique previously described[3].

The accompanying graph shows results obtained, using a MacMichael viscosimeter, when varying amounts of caustic soda and barium hydroxide were added to electro-dialysed kaolin and bentonite suspensions. The suspensions containing caustic soda showed little or no thixotropy, but it was very pronounced for barium hydroxide - bentonite suspensions from about *p*H 4 upwards. The results indicate the importance of the nature of the metallic ions associated with a clay and suggest that the presence of certain ions may be essential for thixotropy.

Complete data will be published elsewhere.

G. BROUGHTON.
R. S. HAND.

Massachusetts Institute of Technology, Cambridge, Mass. June 21.

[1] Houwink, "Elasticity, Plasticity, and Structure of Matter", 351 (Cambridge, 1937).
[2] Hamaker, *Rec. Trav. Chim.*, **56**, 1 (1937), and other papers.
[3] Broughton and Windebank, *Ind. Eng. Chem.*, **30**, 407 (1938).

## Estimating Numbers Without Counting

IN ecological work it is often necessary to have comparative estimates of the numbers of organisms in a large number of samples. An exact valuation may not be required, but an approximate numerical estimate is always preferable to statements in such terms as few, many, very many, etc. The following method was devised to furnish estimates rapidly and without counting of the numbers of a few of the more important species of the marine plankton where only one or two such species formed the bulk of the samples and *where an estimation within ± 15 per cent of the actual numbers would be sufficient.* Actually the plankton is as a rule so mixed that the method can only be applied to special series of samples and not to normal survey work. It is thought, however, that the method, which is believed to be new, may be of value to workers in other fields: perhaps for estimating the seed production of a large number of plants or samples of small insects all of one species.

The method is akin to the colorimetric method and the name proposed for it is the *plethometric method* (πλῆθος: an aggregation or multitude), kindly suggested by my colleague, Prof. T. E. Jessop.

A scale of dots is made as in Fig. 1. The dots are so arranged that when a mask with a circular opening is placed over the scale, the number visible will increase by a definite amount as the mask is slid from left to right. At *A* the number visible is 110, at *B* it is 230 and at *C* it is 270. From such a scale others can be made having, instead of dots, life-size photographic images of the objects to be estimated. A strip of glass coated with glycerine jelly is laid upon the original scale and one of the objects dropped into position over each dot, and then the whole is photographed and enlarged to natural size. Scales

for common plankton animals such as *Calanus*, *Sagitta* and *Limacina* were very skilfully made for me by Mr. J. H. Fraser, when a member of my staff. Such scales are mounted in a frame to wind off one roller on to another below a circular opening as in Fig. 2, the rollers being turned at *X* and *Y*. Alongside is placed the sample in a circular dish of the same size as the said opening, and the sample is spread as evenly as possible by a needle or brush. The scale is turned to right or left until its number

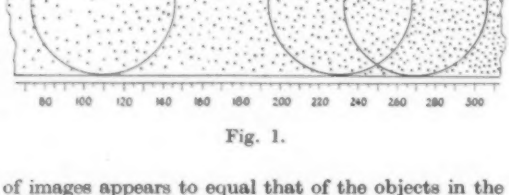



Fig. 1.

of images appears to equal that of the objects in the sample; with practice this may be done very quickly, and usually to within ± 10 per cent. The number is read off through the opening *n*, which may be kept screened by the slide *s*, until the judgment is made. When once such a scale is made, hundreds of samples can be dealt with in a very short time. Even without a photographic scale, a scale of dots roughly the size of the objects in the sample will serve for providing an approximate estimation.

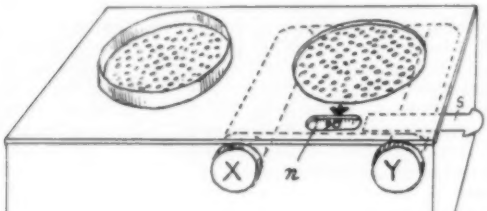



Fig. 2.

My friend, Dr. E. O. Halliwell, has suggested that it might be applied to the rapid estimation of blood corpuscles in place of the usual counts. A double microscope with a single but divided eyepiece would enable one to compare a blood sample with a photographic scale or a slide of increasing numbers of actual corpuscles prepared as a permanent mount. Experiments we have made using two microscopes and a comparator eyepiece indicate that it should be as accurate as the use of the ruled counting slide, and very much quicker.

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June 21.

## Assignment of the Fundamental Frequencies and Computation of the Potential Function of Tetrachlorethylene

THE vibration spectrum of tetrachlorethylene has been discussed by me[1] and later by Linnett and Thompson[2]. It is of particular interest in that the value for the C—C force constant ($6{\cdot}25 \times 10^5$ dynes/cm.) seemed abnormally low for a double bond. This was taken to indicate resonance between other possible structures in which the carbon atoms were linked by a single bond.

In both the above investigations a simplified type of potential function was employed in which many interaction terms were ignored. The importance of those terms has since been demonstrated by the work of Manneback[3] and others[4] on the spectrum of $C_2D_4$. I have therefore undertaken a re-investigation of the spectrum of $C_2Cl_4$ using a potential function of the type employed by Manneback and Verleysen[5].

Assuming for the nine planar frequencies of the molecule the values (in Manneback's notation) $S_1$ (1569, 445, 383); $A_1$ (913, 400*); $A_2$ (802, 346*); $S_2$ (512, 341) a thirteen-constant potential function is necessary to obtain real solutions in the four groups. I have attempted to approach as much as possible the valency-deformation system; nevertheless the values of interaction constants are very important (20 per cent of the principal terms) so demonstrating the great influence of Cl atoms.

The detailed result cannot be quoted here, but it is sufficient to remark that the value for the C—C force constant is now $8 \times 10^5$ dynes/cm. instead of $6{\cdot}25 \times 10^5$. It would therefore appear that the earlier conclusions regarding the existence of resonance in this molecule may be premature, since it is possible to correlate the frequencies with a force field in which the C—C constant has its normal double-bond value.

The other important point to which I would direct attention concerns the assignment of the fundamentals, where it will be noticed that the value for the lowest of the $S_1$ group is taken as 383 cm.$^{-1}$ instead of 236 cm.$^{-1}$, which represents a motion out of the plane. This is based on the polarization measurements of Heidenreich[6]. The above set of fundamentals allows of easy interpretation of the remaining observed frequencies as simple addition bands.

Detailed calculations and discussion will appear shortly elsewhere.

JULES DUCHESNE.

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University, Liège.
June 2.

* 400 and 346 frequencies have been computed from the relations between the forces and the known frequencies.

[1] Duchesne, NATURE, **139**, 288 (1936); **139**, 634 (1937).
[2] Linnett and Thompson, NATURE, **139**, 509 (1937).
[3] Manneback and Verleysen, *Ann. Soc. Sci. Bruz.*, **56**, 349 (1936); **57**, 31 (1937).
[4] de Hemptinne, Jungers and Delfosse, NATURE, **140**, 323 (1937). Sutherland and Conn, NATURE, **140**, 644 (1937).
[5] Heidenreich, *Z. Phys.*, **97**, 277 (1935).

## Distribution of Fluorescence Excitation of Bivalent Europium in Calcium Fluoride and of Bivalent Samarium in Calcium Sulphate

IN the course of the investigation of the fluorescence of fluorite conducted in the Institut für Radiumforschung, Vienna[1], it seemed desirable to determine the distribution of excitation in fluorite for the blue $Eu^{++}$ band.

A series of limited portions of the ultra-violet spectrum of an iron arc was successively allowed to fall on the powdered sample in a flattened quartz test tube. The blue fluorescence thus excited was photographed on different parts of a Kodak Panatomic film behind a filter to keep out the ultra-violet light. The transparency of the developed film was measured with a barrier layer photo-cell. Taking into account the energy distribution in the spectrum of the iron arc, maxima of the blue fluorescence were found for the following wave-lengths of the exciting light: for synthetic calcium fluoride with $10^{-3}$ or $10^{-4}$ europium and in sodium chloride with $10^{-4}$ europium, all after treatment with radium rays, from 230 to 240 mμ, 260, 280, 350 and 385 mμ; for natural fluorite from Weardale (purple) practically the same wave-lengths, only, instead of the last-mentioned maximum, one at 400 mμ[1]. For longer wave-lengths the method is not applicable because of the overlapping of exciting and emitted wave-lengths.

Calcium sulphate with $10^{-2}$ samarium gives after radium treatment for the red Sm++- fluorescence, maxima of excitation at 240, 350, 370 and 400 mμ. Treatment of calcium sulphate with $10^{-3}$ samarium with light of wave-length 240 mμ has the same effect as that with radium rays: the untreated preparation shows, when illuminated with filtered ultra-violet light, only the well-known lines of trivalent samarium; but after prolonged treatment with wave-length 240 mμ, the red and infra-red bands 630 and from 689 mμ to 734 mμ appear on illumination with filtered ultra-violet. In calcium fluoride with europium also the wave-length 240 mμ seems to produce the same effect as radium rays.

Presumably the excitation maxima of shorter wave-length are connected with the *formation* of excited bivalent rare earth centres (reduction of the trivalent rare earth ions), those of longer wave-length with the excitation of such centres already formed.

H. PH. ECKSTEIN.

Vienna. July 4.

[1] See the report by K. Przibram in *Z. Phys.*, **102**, 331 (1936); **107**, 709 (1937); and also NATURE, **141**, 970 (1938).

[1] Groot, W. de., *Arch. Neerland.*, iiia, **7**, 207 (1924), had already found two regions of excitation in fluorite: below 230 mμ and between 340 and 380 mμ.

## Crystal Structure of Thianthren and Selenanthren

IN a recent paper by Cullinane and Plummer[1] on the isomorphous relationships of some analogous organic derivatives of oxygen, sulphur and selenium, we gave the results of some preliminary crystallographic measurements on thianthren and selenanthren (diphenylene disulphide and diphenylene diselenide). The crystallographic measurements have now been completed and an X-ray determination made of the sizes of the unit cells. The results are here given and refer to a different *c*-axis from that quoted in the paper by Cullinane and Plummer.

The crystallographic measurements show that thianthren and selenanthren, which crystallize in the monoclinic system, are isomorphous. This result is in agreement with the conclusions of Cullinane and Plummer. Our observations also show that the unit cell for thianthren chosen by Prasad, Shanker and Peermohamed[2] is face-centred in the basal plane and is therefore not primitive. This agrees with the remark to that effect made by Cox[3]. Our photographs confirm the assignment of the space-group $C_{2h}^5$ to thianthren made by Prasad, Shanker and Peermohamed and show that selenanthren also belongs to the same space-group.

Full details of the work will be published elsewhere.

Thianthren: $a : b : c = 2{\cdot}37 : 1 : 1{\cdot}95$, $\beta = 110° 0'$
$a = 14{\cdot}3$ A., $b = 6{\cdot}09$ A., $c = 11{\cdot}8$ A.
Selenanthren: $a : b : c = 2{\cdot}36 : 1 : 1{\cdot}97$, $\beta = 110° 20'$
$a = 14{\cdot}5$ A., $b = 6{\cdot}21$ A., $c = 12{\cdot}1$ A.

J. EDGAR CRACKSTON.
R. G. WOOD.

University College,
Cardiff.
July 6.

[1] Cullinane and Plummer, *J. Chem. Soc.*, 63 (1938).
[2] Prasad, Shanker and Peermohamed, *J. Ind. Chem. Soc.*, **14**, 177 (1937).
[3] Cox, *Chem. Soc. Annual Reports*, **34**, 189 (1937).

## Colchicine and Acenaphthene as Polyploidizing Agents

KOSTOFF[1] has recently directed attention to the similarity in action of colchicine and acenaphthene, and recommended the latter substance for purposes of chromosome doubling. Preliminary tests with acenaphthene used in saturated solutions of liquid media[2] adapted to the observation of mitosis in stamen hairs of *Tradescantia* give no indication that acenaphthene is at all comparable to colchicine as a polyploidizing agent. After 2 and 4½ hours, counts of nuclear stages showed the following percentages:

| | Prophases | Prometa-anaphases | Telophases | |
|---|---|---|---|---|
| Acenaphthene | 9 | 3·7 | 7 | } 2 hours 200 cells |
| Check | 11·8 | 4·5 | 9·7 | |
| Acenaphthene | 9·4 | 1·9 | 7·5 | } 4½ hours 100 cells |
| Check | 9·6 | 1·6 | 9·6 | |

Not a single polyploid cell was formed in this experiment, nor were any nuclei observed showing chromosomes in metaphasic condition typical of colchicine. Young plants of marigold, tops of which were immersed for 1–48 hours in culture solution[2] saturated with acenaphthene, showed during the successive week effects distinct from those of colchicine.

Kostoff[3] has meanwhile changed his method of application of acenaphthene. Instead of using saturated solution he now brings crystals into contact with the plant material. Certain phases of the acenaphthene reaction apparently resemble that of colchicine. More work is required before the effects can be compared. Any reversible reaction of the type described by Kostoff, if easily applied, widens the possibilities of inducing somatic changes in clonally reproducible plants.

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Agricultural Experiment Station,
Geneva, N.Y.
July 12.

[1] Kostoff, D., *C.R.*, U.R.S.S., **19**, 197–199 (1938).
[2] Nebel, B. R., and Ruttle, M. L., *J. Heredity*, **29**, 1–9 (1938).
[3] Kostoff, NATURE, **141**, 1144–1145 (1938).

## Effects of Floods in East Norfolk

A RECENT visit to the part of East Norfolk flooded by the sea in February and April of this year was made memorable by a succession of south-westerly gales towards the end of June. The best point from which to see the flood damage was found to

be at Horsey Staithe. Looking north-eastwards an astonishing spectacle met the eye. To the left there was a summer scene of woods and cottages clustered round Horsey Hall and Horsey Church, where a slight elevation of the ground had left an island during the advance of the sea. In front, the sea's retreat had left a red desert towards which the gale raced during the forenoon and early afternoon when the local land breeze reinforced it, a region later to be haunted by the melancholy piping of redshanks and the anxious cries of a cloud of lesser terns and ringed plover, when there came the calm of the evening before the setting in of the prevailing south-east breeze. This red desert, so recently part of the North Sea, ended in an imposing greyish-yellow barrier where the sand dunes were being rebuilt with the aid of a crane fed by a hastily constructed light railway.

During the worst of the gales, that of June 20, smoke was seen, rising apparently from one end of the barrier itself. What could be burning up there on that barren sand? In a few moments the mystery was solved; a steamer appeared, its funnel visible almost down to deck level. This was no mirage, but evidence that it was high tide and that if the gale were to veer to north-west the scouring undertow would soon resume its work of destruction. But the people of the village showed no signs of fear even during the height of the gale, for they retain unspoiled, many of them, the hardy spirit of the men who used to set out from Denmark in mid-winter for Iceland or Greenland in open boats and often arrived at their destination. To the Londoner or 'foreigner' as he is termed by the Broadsmen, Horsey Staithe did not seem to be a place in which to linger on that June morning.

Leaving the ruined bird sanctuary on the southern side of Horsey Mere to one's left and taking a path which leads past sledge-covered shallows, where the bittern can still be found, to Waxham Cut, the scene began to change. An arm of the red desert on the right presented a more than wintry landscape; the nearer trees were rust red and more gaunt than trees in their winter sleep, but on the banks of the Cut bright green sedge was springing up. On the calmer days earlier in the month, reed buntings were to be seen as usual, and many swallow-tail butterflies.

The old farm-house by the bridge, where so many bird lovers have gathered during the past five years, luckily escaped the flood with a few scars only. Some of the trees had sucked up the brackish water and assumed the rust red of the neighbouring plain, but others were in their summer green. From this point to Waxham village and Palling, the countryside had its usual summer appearance, apart from the effects of the drought of the previous four months. Only the presence of workmen strengthening and renewing the dunes at Palling gave a hint as to where the next assault of the sea might be expected, while the large and now rarely used parish church at Waxham was a reminder that the sea's advance has in the course of centuries swallowed up miles of once-prosperous countryside.

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## Points from Foregoing Letters

PHOTOGRAPHS showing the interference pattern of light scattered by thermal agitation (elastic weights) in a clear crystal of gypsum are submitted by Sir C. V. Raman and C. S. Venkateswaran. The displacement of the three components into which the incidental radiation is split indicates, according to Brillouin's formula, acoustic wave velocities of 3,350, 2,050 and 1,100 m. per sec.

A hundredfold increase in the ionization at an equivalent height of 125 km., slightly higher than the normal *E* region, which occurred on October 1, 1937, at 0927 G.M.T., is ascribed by R. Naismith and W. J. G. Beynon to a bright solar eruption the appearance of which was reported by the Greenwich Observatory at practically the same time.

Dr. A. Soltan has measured the effective cross-section for collisions of fast neutrons with atomic nuclei. The sticking probability appears to be less than unity, at least for heavy nuclei.

From the persistence and rate of decrease in intensity of the band spectrum of helium gas (at 25 mm. mercury pressure), Dr. S. P. McCallum and M. S. Wills infer that either the helium molecules formed in the electric discharge have a life of the order of 1/600 sec. or, more probably, they are formed after interruption of the discharge by the collision of a metastable atom with a neutral atom.

A photographic study of the relations between the magnitude of the mosaic structure of crystals and the intensity of X-ray reflection shows, according to Prof. V. Dolejšek, M. Jahoda, J. Ježek and M. Rozsíval, that the case of specially selected crystals of calcium sulphate, sodium chloride and zinc sulphide, the product of the exposure and the magnitude of the ideal mosaic is constant.

Using an electrolytic reduction technique W. E. Campbell and U. B. Thomas show that films 30–60 A. thick, as oxide, are formed on copper during abrasion by French emery, whether carried out in air, under benzene, or under water.

Commenting on Ratcliffe and Kownacki's suggestion to utilize slowly moving ions in place of electrons in a thermionic tube, in order to decrease the frequency at which inertia effects become appreciable, Dr. J. S. McPetrie refers to an alternative method in which a magnetic field of suitable magnitude is applied to the valve in the direction of the electrode axis.

A table giving the mobility and other properties of kaolin clays of known particle size, and graphs showing the effect of *p*H and valency of cations upon the yield value of aqueous suspensions of such clays, are submitted by G. Broughton and R. S. Hand.

A method of rapidly estimating within about fifteen per cent the number of small organisms, seeds, etc., in samples, by comparison with a photographic scale of equal size dots or objects, of known density, is described by Prof. A. C. Hardy.

A reinvestigation of the spectrum of tetrachlorethylene, $C_2Cl_4$, using a potential function of the type employed by Manneback and Verleysen, leads J. Duchesne to a value of $8 \times 10^5$ for the C—C force constant instead of $6{\cdot}25 \times 10^5$, so that the frequencies can be correlated with a force field in which the C—C constant has its normal double bond value.

# Research Items

### Property among the Ciga of Uganda

THE Ciga of Uganda and Ruanda, whose system of property holding has been studied by Miss May Mandelbaum Edel (*Africa*, **11**, 3; 1938), unlike most people of this area, were not ruled by Hamitic overlords, and when British dominion was established over them were independent. The basis of their livelihood is horticulture, the fields covering the hillsides beside their houses, which are grouped in rambling hamlets. The staple food is eleusine, eked out by peas, beans, corn and wild greens. They also keep cows, goats and sheep, but the cows are not surrounded by an aura of sanctity, nor are the traditional taboos of their pastoral neighbours observed. Herding does not set the *tempo* of life. Industrially they have knowledge of all the techniques practised among the serfs of their neighbours, including iron smelting; but some pursuits are the work of specialists. The important social group is the household. Ownership is essentially individualistic. Clothing and ornaments, utensils, furniture, animals, food and land—to all these individuals, particularly adult male family heads, have exclusive claims. This claim is acquired through manufacture, gift, certain forms of seizure, purchase or inheritance, and the owner may dispose of his property in many different ways. The word *nyina*, used to designate ownership, has an important extension in reference to a compound, where it includes command over the persons of the household. In his economic transactions, the master of a household need submit to no higher authority than his own. He may lend, give away, sell or destroy any of his possessions. The one kind of control which does not occur among the Ciga is testamentary. A man cannot legislate about the disposal of his possessions after his death. The individual character of property is sharply brought out by the marriage arrangements, the father alone receives the bride-price. The individual kraal head is also his own master with regard to agricultural land. When once a man has acquired title by marking off its boundaries with a hoe, it remains his indefinitely and passes to his heirs. Except indirectly, women cannot own property.

### Jew's Harps from Hainan Island

A GAP in the study of the distribution of the jew's harp is filled by Mr. Chungshee H. Liu in an account of three such instruments recently discovered in the course of anthropological investigations among the Li people of Hainan Island (*K'o Hsüch* [*Science*], **22**, 1–2; 1938, Shanghai. In Chinese with English abstract). The existence of the jew's harp has been traced by many investigators among various tribes in south and east Asia and in the islands of the Pacific. Chinese scholars of ancient and modern times have recorded its use by the tribesmen along the south-western borderland of China. The original home of the instrument is said to be southern Asia, somewhere along the border-line between Burma and Yunnan. It has a wide distribution in India, Nepal, Tibet, Assam, Burma, Siam, Indo-China, Malaya, Formosa, Japan (Hokkaido), and from Borneo to the Philippines, Fiji and Samoa. Of the three examples discovered in Hainan in 1934, two are of bamboo and one is of brass. Although small in size, they have a pleasing tone. Judged by their structure, they are genealogically related to those harps which are used by the Lissu of Yunnan, the Chin of Burma, the Naga of Assam and the Fan of Formosa, as well as allied with those of the Ch'iang of Chinghai or the Lolo of Szechuan. The discovery of the jew's harp as a cultural trait among the Li people of an Indonesian culture area fills, therefore, a lacuna in its geographical distribution and provides evidence long desiderated by students of ethnology.

### Leaf Extension in *Cladium*

MISS VERONA M. CONWAY has carried out extensive observations on the rate of extension of the inner leaves of the shoot of *Cladium Mariscus*, in Wicken Fen and under various experimental conditions (*New Phyt.*, **37**, 3; June 28, 1938). Dr. Godwin had noted the great uniformity with which these leaves extend so that if they are all cut off close to the ground, months later, after considerable extension, their cut ends will all be found within a millimetre distance of one another in length. Very suitable material is thus provided for observations upon the effect of various conditions upon leaf growth, and thus conclusions may be drawn as to the habitat conditions that are optimal for the species. Miss Conway's observations have led her to the conclusion that the extension rate is closely correlated with temperature and therefore shows a strong seasonal periodicity. It is also inhibited by strong light and therefore takes place mainly at night; the rate does not vary greatly in the course of any one night, when its magnitude seems largely determined by the temperatures of the preceding day. If the plant is growing in soil which is not saturated with water, it shows a lower extension rate, and Miss Conway concludes that optimal conditions for the growth of *Cladium* include a completely water-logged soil.

### Economic Aspects of Potato Viruses

Two papers which lead towards a fuller understanding of the economic production of potato stocks free from virus diseases have recently been published. J. B. Loughnane and Paul A. Murphy show (*Sci. Proc. Roy. Dub. Soc.*, **22**, 1; May 1938) that two potato viruses, namely *X* and *F* (*Solanum* viruses 1 and 8 respectively) are transmitted from plant to plant by contact of the foliage. This happened in the still air of an insect-free greenhouse, but was accentuated when the foliage was agitated by wind. Miss Phyllis Clinch, J. B. Loughnane and Paul A. Murphy further demonstrate (*Sci. Proc. Roy. Dub. Soc.*, **22**, 2; June, 1938) that *Solanum* virus 1 spreads considerably under field conditions, even in stocks of potatoes selected for their freedom from virus diseases. The combined results are

important, for anyone who has been concerned with the production of clean stocks of potatoes can relate annoying occurrences of virus *X*. It is now clear that greater attention must be paid to the initial elimination of this disease from nursery stocks, whilst a further practice of wide planting to avoid contact of the foliage, at least in the early stages of isolation, should also minimize still further any chance of infection.

### The Hypocreales

LITERATURE upon the classification of the Ascomycetes and particularly the Pyrenomycetae, is comparatively unavailable to the general student of mycology. There is, in fact, no collected account of later date than Cooke's "Handbook of British Fungi", published in 1871. A critical study of the Hypocreales, a section of the Pyrenomycetae, by T. Petch, is therefore most welcome ("British Hypocreales", *Trans. Brit. Mycol. Soc.*, **21**, Pts. 3 and 4, 243; June 1938). The family Hypocreales includes several fungi of extensive pathogenicity, notably *Dialonectria galligena*, the cause of apple canker, and *Claviceps purpurea*, or ergot of rye. Citation of the genera *Nectria*, *Epichloë*, *Melanospora*, *Claviceps* and *Cordyceps* should commend the importance of this family even to the amateur mycologist, whilst the specialist finds a highly critical monograph of the forty-one modern genera now comprised in the Hypocreales. Mr. Petch has described two new species in the course of his investigations, namely, *Calonectria tessellata* and *Gliocladium strictum*. Thirty-nine text figures illuminate general structure and spore form.

### Bacterial Rotting of Begonias

Messrs. W. J. Dowson, W. C. Moore and L. Ogilvie have recently described (*J. Roy. Hort. Soc.*, **63**, 6; June 1938) a bacterial disease of begonias, which appears to be already distributed somewhat widely in England. Leaves are at first spotted with glassy areas, and later turn brown, whilst the rot spreads to the petioles and stems, causing death of the plant. The pathogen is a yellow bacterium which is provisionally diagnosed as *Pseudomonas begoniæ*, and its disease-producing effect has been established by isolation and re-inoculation. Control lies in the destruction of infected plants followed by such garden hygiene as the propagation of disease-free cuttings in sterilized soil.

### The Fluorine Molecule

THE internuclear distance in the fluorine molecule has been calculated as 1·45 A. by L. O. Brockway (*J. Amer. Chem. Soc.*, **60**, 1348; 1938) from electron diffraction measurements in the gas. Half this value is 0·73 A., whereas the covalent radius for the fluorine atom obtained by extrapolation of the carbon, nitrogen and oxygen radii and also obtained from the observed distance in methyl fluoride is 0·64 A., so that the distance in the fluorine molecule is about 14 per cent greater than the value expected for a normal covalent single bond. The author points out that the accuracy attained was, on account of experimental difficulties, less than that of other electron diffraction determinations, but considers that the result is not in error by more than about 0·05 A.

### Hydration and Denaturation of Proteins

ON the cyclol theory, proteins have cage-like molecules. Water can be associated with these molecules in three ways: first, by direct co-ordination with the fabric; secondly, inside the hollow shell of the molecule; thirdly, in the protein crystal, in the inter-molecular spaces within the crystal cell (D. M. Wrinch, *Phil. Mag.*, **25**, 705; 1938). It seems likely from the open lattice structure of the protein molecule, that many protein crystals will contain not only water molecules but also foreign ions. The crystallizability of the native proteins indicates that their molecules must have a more or less rigid structure. All the amino-acid residues of the native protein are present in the denatured protein, yet the latter has never been obtained crystalline. Wu concludes that there must be some linking of the residues in the native protein which has been loosened in the denatured protein, allowing the molecule to become flexible. Northrop points out the entropy of native protein is very much less than that of denatured protein, suggesting that the former has a fixed configuration and the latter a number of possible configurations. The cyclol cage has regions of greater and lesser stability, and any factor increasing the instability of a particular region could lead to a tearing open of the cage molecule. The migration of protein molecules to an aqueous surface could form such a factor, since the passing of the hydrophobic R groups out of the water at the surface would lead to a general disturbance of the water relations of the protein molecule. Protein molecules are denatured when they form films and lose water of hydration. The thickness of the film may be as small as the thickness of a single amino-acid residue, suggesting a complete tearing open of the cage-like molecule. On the other hand, it may be greater, suggesting partial opening or the folding over of a flat fabric.

### New Application of Photo-electric Cells

THE practical applications of photo-electric cells are continually expanding. According to a report issued by Science Service of Washington, D.C., C. W. La Pierre and A. P. Mansfield, of the General Electric Company of America, have described a machine to the American Institute of Electrical Engineers which determines the skew of the cloth and controls the apparatus which straightens it. When cloth leaves the loom, warp and weft—the lengthwise and crosswise threads—are perpendicular to each other, but after the cloth has been bleached, washed, starched and dried the weft may be appreciably out of position. This skew is important, because any designs printed on the cloth will be distorted after the cloth is cut into small pieces. The cloth is straightened by passing it through a device called a 'tenter', which contains fingers for gripping the edge of the cloth and stretching it while still wet so as to eliminate the skew. Formerly the controls were hand-operated, the operator gauging the amount of stretch by the simple expedient of watching the cloth carefully; but this procedure is subject to human limitations and is only satisfactory for relatively coarse weaves and low cloth speeds. The authors state that by means of their electrical device the work can be done much faster and more accurately.

# Carbohydrates of Well-Defined Molecular Weight in Plant Juices

By Prof. The Svedberg and Nils Gralén, Institute of Physical Chemistry, University of Uppsala

THE attempt to bring the solid carbohydrates of plants and animals, for example, cellulose, starch, glycogen and their derivatives into solution has so far resulted in polydisperse systems not possessing well-defined molecular weights[1]. This fact may be taken as an indication that the question is

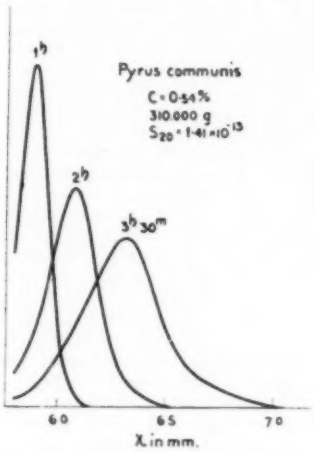



Fig. 1.

wrongly put; that such structures as cellulose and starch do not spontaneously form particles of definite mass (molecules) and therefore cannot be broken down to real molecular dispersion without profound chemical change.

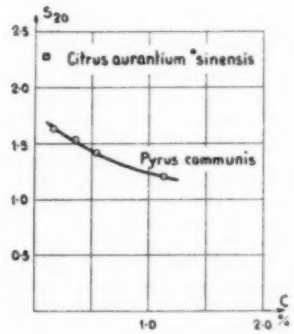



Fig. 2.

In another class of high-molecular compounds, the proteins, we meet with a similar phenomenon. Keratin, fibroin, myosin and other proteins which occur in a semi-solid state do not as a rule give solutions of well-defined molecular weight. On the other hand, all the proteins of the body liquids are characterized by their well-defined molecular weights.

From these statements, it would seem reasonable to conclude by analogy that there is a fair possibility of finding carbohydrates of well-defined molecular weight in plant juices. This would mean that when Nature produces a substance which occurs as a solute in a natural liquid, this substance may form well-defined molecules. We do not know much about the final stages in the building up of cellulose and starch. It is generally believed that the synthesis takes place from the simple sugars through intermediate compounds similar to those observed in the enzymatic breakdown processes studied *in vitro*, but nothing definite is known with regard to those hypothetical stages. It is possible that these substances exist in solution in plants as high-molecular carbohydrates of well-defined molecular weight. From this point of view, an examination of plant juices with appropriate modern methods such as ultracentrifugal sedimentation, diffusion and electrophoresis should be of considerable interest.

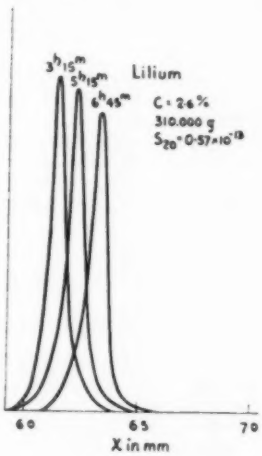



Fig. 3.

So far, we have only made a few preliminary studies of the juices from fruits, bulbs and tubers. The majority of the carbohydrates in fruit juices belong to the pectin class, that is, they contain methylated carboxyl groups; those in the juices of bulbs and tubers are probably regular polysaccharides.

The ultracentrifugal sedimentation and the diffusion of pectin from apples, pears, plums and oranges was determined directly in the juice and on material precipitated with alcohol. These substances are not monodisperse but better defined than starch or cellulose solutions. The pectins from apples, pears and plums have approximately the same molecular weight (25,000–35,000), while that from oranges is definitely higher (40,000–50,000). As an example, the sedimentation and the relation between sedimentation constant and concentration for the pectin in

pear juice is shown in Fig. 1 and 2. A value for the sedimentation constant of orange pectin is also inserted in Fig. 2. The increase of sedimentation with decreasing concentration indicates interaction of the molecules due to dissymmetrical shape or hydration.

The carbohydrates in the juice of bulbs and tubers have proved more nearly monodisperse in sedimentation and diffusion. Fig. 3 shows the sedimentation of the carbohydrate from a *Lilium* bulb. The molecular weight was 16,000.

There is a noticeable change in the sedimentation picture with the development of the plant. When a bulb or a tuber begins to sprout, high-molecular carbohydrates appear in the juice in higher concentration than before. As a rule, two well-defined components can be distinguished. This may be taken as an indication that the breaking down of the reserve carbohydrate (starch or inulin) passes through two steps before the low-molecular stage is reached. As examples, in Fig. 4 the sedimentation diagram from the juice of a dormant potato tuber (*A*), from one just beginning to sprout (*B*) and from one in the midst of sprouting (*C*) is given. With increased activity the two high-molecular components become more and more noticeable. The dotted curve in (*A*) represents the sedimentation of the juice after removing the low-molecular material by dialysis. This shows that the two maxima are present even in the juice of the dormant tuber although in very low concentration. Similar curves have been obtained with the juice from the tubers of *Helianthus tuberosus* and *Ranunculus ficaria*, and from hyacinth bulbs.

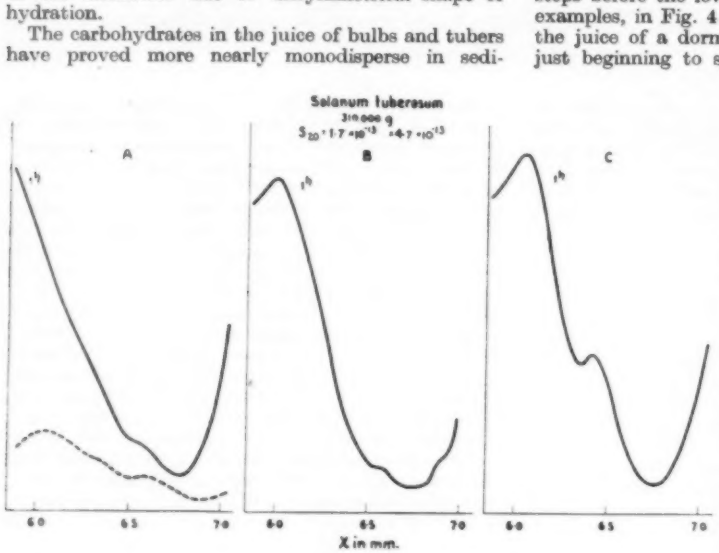


Fig. 4.

By ultracentrifugal analysis we have also found traces of obviously monodisperse high-molecular compounds, probably carbohydrates, in the juice from hyacinth leaves and in the sap from birch trees.

It is hoped that investigations along these lines will help to throw some light on the processes of carbohydrate metabolism in growing plants.

[1] Kraemer, E. O., and Lansing, W. D., *J. Phys. Chem.*, **39**, 153 (1935), for cellulose. Lamm, Ole, *Kolloid-Z.*, **69**, 44 (1934), for starch. Record, Basil R. (unpublished), for glycogen.

# Physical Chemistry of Surfaces

## Annual Meeting of the Bunsen-Gesellschaft

THE forty-first annual assembly of the Bunsen-Gesellschaft was held in Breslau on June 2–3, the principal theme of discussion being "The Physical Chemistry of Surfaces". The symposia of the Bunsen-Gesellschaft are organized somewhat differently from those of its younger sister, the Faraday Society. All papers are delivered in full, only abstracts being available beforehand. Papers delivered fall under three heads: (*a*) summary reports, invited from various experts, intended between them to cover the whole field of discussion, (*b*) shorter contributions bearing on the main theme, (*c*) miscellaneous physico-chemical contributions. (*b*) and (*c*) were delivered in parallel sittings. This produced a very full two-day programme with little time for discussion—in fact there was no time whatever for public discussion on section (*a*). This disadvantage is appreciated, and the society has recently adopted a policy of holding smaller extra *Tagungen*, more after the model of the Faraday Society, in which discussion can be a principal feature.

Prof. P. A. Thiessen made some general introductory remarks and took the chair. R. Brill discussed surface films on water, a method of investigation which has been somewhat neglected in Germany since the time when Fräulein Pockels, its originator, had to arouse Rayleigh's interest to secure publication of her work. He discussed in great detail the two-dimensional equation of state, and finally the work of Blodgett and Langmuir on built-up multilayers. Of all recent developments mentioned in the symposium, the latter undoubtedly shows the most promise of great expansion and exciting progress. In a single lecture of such detail it was naturally impossible to deal with everything, but it is unfortunate that such well-established novelties as measurement of film potentials and the investigation of chemical reactions in monolayers were never brought before the meeting.

An interesting paper by K. Neumann concerned molecular motion in surfaces. He dealt first with the streaming set up at liquid surfaces by capillary forces, which often plays a large part in the rapid dissolution of surface-active substances; and, secondly, with surface diffusion on solids—a field of research first opened up by the work of Volmer and Estermann on the growth of mercury crystals. Both experiment and simple theoretical considerations

show that the activation energy for change of position of a molecule on a crystal surface is roughly one fifth of the heat of evaporation, whence it follows that a molecule after condensation will usually change its place some thousands of times before evaporating again. This enables the regular growth of crystals, which is otherwise difficult to reconcile with the existence of condensation coefficients of the order of magnitude 1. The activation energy for the motion of single ions on the surface of an ionic crystal is not much less than the heat of evaporation, but adsorbed pairs of oppositely charged ions can readily move around one another. This accounts for the surface diffusion of sodium chloride, for which experimental evidence was presented.

O. Hahn reported on the investigation of surface processes by radioactive methods. Of particular interest is his "emanation method" of investigating the 'inner surface' of a solid. This is a development from the older adsorption method used by Paneth. Hahn makes solid preparations containing minute quantities of radium, and determines the nature of the surface by the readiness with which the material gives up emanation. By this means, changes in the surface of a material (for example, iron oxide - hydroxide gel or a catalytic thorium oxide) with time or heating can be followed with great sensitiveness. Later in the meeting, K. E. Zimens reported on theoretical work of S. Flügge which shows that the method can also be used to investigate diffusion constants in solids, in principle quite easily for values as small as $10^{-28}$ cm.$^2$/day. (The smallest *measured* diffusion constant in a solid is $10^{-17}$ found by Cremer in solid hydrogen from the rate of disappearance of isolated *ortho*-hydrogen molecules, which are only destroyed by magnetic reaction with one another.) A very remarkable result obtained by the older methods is that found by K. Starke, that mixtures of $ZnO-Fe_2O_3$ or $ZnO-Cr_2O_3$ in equimolecular (spinel) proportions develop a very much increased adsorptive power for lead above that of the components, even at room temperature.

Th. Schoon dealt with electron diffraction as a means of investigating surfaces. He discussed the evidence for the Lennard-Jones effect (predicted contraction of the surface layers of ionic crystals, and a corresponding expansion in molecular crystals), which remains doubtful, owing to uncertainties about the refractive index for electrons of the possible presence of adsorbed gas layers. Among other points dealt with were the depth of penetration of electrons, by which is meant the depth to which an electron at grazing incidence (3°) can pass in and out of the crystal, being scattered only once. From the fact that with 25 kv., cetyl palmitate and stearic acid crystals, grown from hydrocarbon solvents, give the same diagram, but differ at 40 kv., it is concluded that electrons at these voltages have respectively shallower and deeper penetrations than 20 A.

P. Harteck dealt with the various types of adsorption (Van der Waals adsorption, capillary condensation, and reversible and irreversible activated adsorption). R. Suhrmann reported on electron emission phenomena. C. Wagner gave a masterly survey of reactions at phase boundaries, classified according to the nature of the velocity-determining stage. This was so closely packed as to be incompressible, and it is recommended that the original paper be referred to when it appears in the *Zeitschrift für Elektrochemie*. K. Fishbeck made much the same attempt with narrower limitations. Finally, G. M. Schwab surveyed surface catalysis. This paper also, unfortunately, lends itself to compression as little as the subject lent itself to compression into a single lecture of 35 minutes.

An arbitrary selection must suffice for the miscellaneous papers. L. Bergmann demonstrated a number of interesting experiments with supersonics. Th. Förster showed how it is that the strength of a C–H bond is influenced by the state of binding of the carbon (single, double or triple bond, or strained ring). The mutual influence arises from the fact that the sum of the mixture ratios of $2s$ and $2p$ states in the four bonds must remain constant and equal to 1 : 3. Reduction of the angle below the tetrahedral angle reduces the ratio below 1 : 3, and hence increases it in the other bonds. The maximum binding is reached with a ratio of about 1 : 1 (C–H bond in acetylene). With nitrogen, the bonding of which is not a mixture of electron states, but purely $2p$ in the first approximation, there is no mutual influence, as the Raman spectra have shown. Schmid and Larsen showed that the increase of conductivity at high frequencies ($\lambda$ = 12 m. and 20 m.) is very large in solutions of soaps, etc. containing ionic micelles. This indicates that the reduced conductivity and activity in such solutions is a Debye-Hückel electrostatic effect (theory of Hartley and others) rather than reduced dissociation as supposed by McBain. H. J. Antweiler and M. v. Stackelberg reported further experiments on the peculiar currents of liquid, with speeds up to 8 cm./sec., which are set up in the electrolyte at liquid metal cathode surfaces under certain conditions. This can now be satisfactorily interpreted as a cataphoretic effect. K. Clusius and K. Weigand have measured the pressure dependence in the transformation II (isotropic) $\rightleftarrows$ III (anistropic), in solid hydrogen sulphide and heavy hydrogen sulphide. The hysteresis in this change is still something of a mystery, but the authors suppose it means that many molecules must become rearranged simultaneously. X-rays indicate that the *S*-atoms scarcely move in the transition. F. C. Frank presented a descriptive theory of the phase-change liquid to liquid-crystal, showing the way in which the quasi-crystalline structure of the former can develop semi-continuously into the latter. This was intended to be a contribution to the general theory of phase changes from the point of view that this is one of the simplest of all crystal–non-crystal transitions.

On the whole, in spite of the high quality of individual contributions, the meeting produced nothing of great novelty. This applies particularly to the main theme. Partly this reflects a certain lack of enterprise in German physical chemistry, which is at the moment mainly distinguished by painstaking covering of well-trodden ground; partly it indicates that the time was well chosen for a summarizing symposium designed to report progress, rather than to make it.

There were as usual a number of social events in a programme which scarcely left a minute unprovided for. Of these the most memorable was a concert in the *Schloss*, with music by Mozart and Frederick the Great—the latter appropriately as the one who gave the *Schloss* its present inner form. At the final dinner, we learnt that this was the fortieth *Bunsentagung* which Prof. Bodenstein had attended, without interruption. Finally, many members took part in a visit to the Waldenburger Bergland and Salzbrunn, and some continued home *via* the ridge-way of the Riesengebirge.

F. C. FRANK.

## Guy's Hospital Medical School

### New Institute of Pathology

THE new Pathology Building at Guy's Hospital Medical School, which was opened on June 23 by the Chancellor of the University, the Earl of Athlone, completes the rehousing of the School and Hospital laboratory departments. It makes a valuable addition to the facilities available for carrying on medical research in London by providing suitable modern accommodation in close association with one of the largest hospitals.

In welcoming the Chancellor, the Dean of the Medical School pointed out that a comparatively small number of hospitals, such as Guy's Hospital, which had originally been founded for the care and cure of a small neighbouring population, had developed into the training ground for the medical services of the nation. To-day, however, the solvency of these hospitals is in imminent danger, and the whole clinical training of the medical student is not only handicapped but is also seriously threatened by the desperate financial straits in which these essential hospitals find themselves. "It is one of the queerest anomalies," he said, "of this British civilization that the training for the most important and most devoted of its public services should be hampered at every stage by being committed to an existence of perpetual mendicancy."

The Chancellor, in replying, stated that the University viewed with great satisfaction every effort made by its constituent schools to provide themselves with accommodation and equipment worthy of institutions of university status, and he congratulated the Medical School of Guy's Hospital on the fulfilment of its wise policy of concentrating all the departments of the School on one site. He also said that the University recognizes with appreciation that the present building has been largely paid for out of the ordinary funds of the School, without public appeal, though with some financial assistance from the Court of the University. "The reputation of the hospital," he said, "depends on its school, and the reputation of the school depends on the financial stability and efficiency of the hospital."

The opening of a large modern medical school building designed to afford extensive accommodation for research, provides an opportunity of directing general attention to the seriousness of the position in which those responsible for medical education in this country are now finding themselves placed. The prescribed course of education for a medical qualification is at present divided into two parts of roughly equal length. In London the earlier half is carried out in well-equipped departments, like that now opened at Guy's Hospital, belonging to institutions which are carefully controlled and inspected by the University authorities and liberally supported by University funds. The provisions for teaching in the second half, however, present a striking contrast with those in the first. They depend almost entirely upon materials and facilities provided by more or less independent institutions—the teaching voluntary hospitals—many of which are very much older than the University itself. For some years these essential hospitals have been in straitened circumstances, and the teachers of clinical subjects in their wards and out-patient departments have been faced with increasing handicaps upon their activities. Though these obstacles have been greatly lessened by the loyal support given by the teaching staffs, as well as by the ingenuity of the administration in making resources stretch as far as they will go, it should now be generally realized that medical students are no longer receiving the best training which the medical advances of the past fifty years have made possible. Nor is there any assurance that even the present hospital facilities will be continued in the future on the same level as in the past. In their endeavour to maintain their former predominant position many of the voluntary hospitals, in recent years, have seriously overstrained their resources, and are adding yearly to accumulating deficits. They are faced, therefore, with the very serious alternatives of either curtailing the facilities they place at the disposal of the University for medical education or of extending in some direction the basis of their financial support. What direction such extension should take will require careful consideration, especially in view of the double duty that these institutions undertake: they provide hospital beds for the population of London on the one hand and medical practitioners for the country as a whole on the other. To meet these two distinct claims it would seem that both local and national support must be forthcoming.

## University Events

BELFAST.—Arrangements have been made for co-operation between the University and Armagh Observatory, and Dr. E. M. Lindsay, astronomer at Armagh, has been appointed part-time lecturer in astronomy in the University. Dr. Lindsay will continue to hold his post of astronomer at Armagh.

Mr. O. G. Edholm has been appointed to the newly created lectureship in physiology. Mr. Edholm is at present assistant lecturer in physiology at King's College, London.

CAMBRIDGE.—The electors to the John Humphrey Plummer professorship of mathematical physics have elected Prof. R. H. Fowler, fellow of Trinity College, from October 1. Prof. Fowler resigned from the chair on his acceptance of the directorship of the National Physical Laboratory on the resignation of Prof. W. L. Bragg (see NATURE, June 4, p. 1002); but has been advised to withdraw his acceptance of this post for reasons of health, and signified willingness to be re-elected as professor of mathematical physics.

D. J. Bauer, of Trinity College, has been re-elected to the Michael Foster studentship in physiology for 1938–39. Mr. Bauer, who was educated at King's College School, Wimbledon, graduated with a first class in both parts of the Natural Sciences Tripos. The annual value of the studentship is £105.

OXFORD.—In Convocation on July 30 the honorary degree of D.Sc. was conferred on Prof. C. G. Jung, professor of psychology in the University of Zürich and president of the Tenth International Medical Congress for Psychotherapy meeting in Oxford.

SOUTHAMPTON.—Dr. P. Ford, lecturer in charge of the Department of Economics, has been elected to the chair of economics and head of the Department of Economics and Geography in University College, Southampton.

Miss F. C. Miller has been appointed senior lecturer in geography.

## Science News a Century Ago

### The Horticultural Society

A MEETING of the Horticultural Society was held on August 7, 1838, H. M. Dyer, vice-president, being in the chair. "The specimens," said *The Times*, "exhibited some interesting varieties. One of the most valuable was the vanilla plant, cultivated by Professor Motreu, of Liège, who gave it the same attention as is employed in the cultivation of melons and cucumbers. In the first year of its growth it produced 50, and in the second year upwards of 160 fruits, and the success of its cultivation led to the belief that it might be introduced into Europe as an article of profit. From the gardens of the Society was a Trinidad pineapple, weighing 5 lb. 12 oz. This is one of those extraordinary fruits that grow on that island, near a pitch lake, and are there met with of a weight of 28 lb., which they might attain in this country, were the soil and cultivation properly known." The cultivation of the vanilla plant was dealt with a week or two later by Prof. Motreu in a paper to the British Association in Newcastle.

### The *Athenæum* and School Buildings

IN its issue of August 11, 1838, the *Athenæum* dealt at length with a "Report of the Secretary of the Board of Education on the Subject of School Houses" published at Boston, U.S.A. Always a persistent advocate of national education, the *Athenæum* remarked that, "Habituated as we are to opposition to all national education that is directed to a higher object than a polemic triumph, we were almost startled at the plain good sense of the men of Boston, who have brought their time and attention to bear upon the philosophy of school accommodation". Planning, ventilation, windows, lighting, heating, location, desks and seats, and playgrounds were all the subject of discussion in the report, which said that "when it is considered that more than five sixths of all the children in the State spend a considerable portion of the most impressionable period of their lives in the school house, the general condition of those buildings, and their influence upon the young stand forth at once as topics of prominence and magnitude". All those readers who had the improvement of our domestic education at heart were enjoined to procure reprints of the report for cheap or gratuitous circulation.

### Honours to Men of Science

UNDER the above heading, the *Mechanics Magazine* of August 11, 1838, said: "Sir John Herschel is, we believe, the first Englishman who has ever received a baronetcy purely on account of his scientific acquirements. His father was only a Hanoverian knight, which was also the honour enjoyed by himself previous to the late coronation. Sir Edward Lytton Bulwer is only the second *literary* baronet, having been preceded by Sir Walter Scott. No great inventor has ever received a similar honour; Sir Richard Arkwright was indeed knighted, but that was not on account of his mechanical merits, but in the usual routine, as the bearer of an address of congratulation on His Majesty's escape from the knife of Peg Nicholson, or some equally important occasion." In connexion with this, it may be remarked that Lord Liverpool, when Prime Minister, offered a baronetcy to Watt, who, however, declined it.

## Societies and Academies

### Dublin

**Royal Dublin Society**, June 21.

REPORT OF THE RADIUM COMMITTEE FOR 1937.

10,110 millicuries of radon were issued during the year, and reports received from hospitals and the larger private users record the treatment of 502 cases of malignant and 97 of non-malignant diseases. Of all cases of malignant disease treated by any method in these institutions, more than fifty per cent received radium treatment. Out of a large number of malignant cases, of which detailed results are recorded, some sixty per cent were apparently cured, or at least were free from symptoms at the end of a year. Records are also included showing the number of cases treated in former years which are known to be still alive. One large user comments on the imperative need for taking all possible steps to ensure that patients come forward for treatment before the disease has advanced so far as to render the results hopeless.

W. R. G. ATKINS: A modified use of the hæmocytometer for counting sparse fields. By suitable focusing, it is possible to arrange that the entire circular microscope field just encloses the square millimetre of the hæmocytometer, and thus the entire field being of a known area can be used for counting purposes. In this way, a number of sample counts can be effected on a single slide.

### Paris

**Academy of Sciences**, June 13 (*C.R.*, **206**, 1769–1839).

LÉON LECORNU: The pressures experienced by the envelope of an ellipsoidal balloon.

ROBERT LESPIEAU: The synthesis of adonite.

JEAN TILHO and CAMILLE ARAMBOURG: The discovery, by Stephane Desombre, of a fossil elephant in the centre of the Sahara.

JEAN DELSARTE: Certain functional transformations relating to linear partial differential equations of a second order.

NICOLAS CIORANESCU: A generalization of the first formula of the mean and the polynomials of Tchebichef.

KWOK PING LEE: The multiple values and the directions of Borel of meromorph functions.

ALBERT PFLUGER: The variation of the argument and the distribution of the zeros of a certain class of analytical functions.

JEAN LUNEAU: The influence of the pressure on the resistance to movement in air for very low values of the Reynolds number.

GEORGES DEDEBANT and PHILIPPE WEHRLE: The equations to the probable values of a turbulent fluid.

LUCIEN REINGOLD: The calculation of the temperatures and instantaneous maximum pressures in explosion motors.

FERNAND CHARRON: The distribution of heat between two bodies rubbing together.

RAYMOND JOUAST, MARCEL PICARD and RENÉ HÉROU: The determination of the ratio of the international ohm to the absolute ohm. The method is based on a standard inductance (of known geometrical dimensions) and the frequency of an alternating

current, and gives a ratio of the international ohm to the absolute ohm of 1·00052. This is compared with earlier values, 1·00045 (United States National Bureau of Standards) 1·00050 (National Physical Laboratory), and 1·00048 (Physikalisch-Technische Reichsanstalt, Germany).

PIERRE GRIVET: A new phenomenon in the working of the photo-electric cell at high frequency.

VICTOR SINN: Researches on the reactions at the positive electrode of the lead accumulator. Determination of the amount of sulphuric acid used by the positive plate of a lead accumulator during discharge, when opposed to the hydrogen electrode, gave figures agreeing with the theory of Gladstone and Hibbert within 1 per cent.

JACQUES DE LASSUS SAINT-GENIES: The conditions of correct projection of crimped films.

PAUL GESTEAU: A method for the quantitative analysis of substances in solution by their absorption spectrum in the field of the ultra-violet.

GEORGES ALBERT BOUTRY and JEAN GILLOD: The properties of a new type of photo-emissive cell. Studies of a cell in which the cathode was formed by a thin layer of caesium deposited on silver.

MARCEL MATRICON: The application of the method of the self-consistent field to atomic nuclei.

PAUL LAFFITTE: The projection of flame in gaseous mixtures and on the phenomenon of shock in explosion motors.

GEORGES CARPÉNI: The preparation, electrometry and spectrography in the ultra-violet of *d*-araboascorbic acid.

LOUIS HACKSPILL and LAMBERT A. VAN ALTNEA: The action of caesium on carbon monoxide. Caesium combines at the ordinary temperature with carbon monoxide, even under low pressure, giving a stable exothermic compound $(COCs)n$, probably $(COCs)_3$, reacting with dilute acids giving glyoxal.

ANDRÉ ADRIEN SANFOURCHE: The preparation and properties of the neutral lithium phosphate. Neutral lithium phosphate, free from LiOH, can only be obtained by neutralizing phosphoric acid with the exact proportion of lithium hydroxide. Its composition is $Li_2PO_4 . 9·5\ H_2O$.

MME. YVONNE KHOUVINE, GEORGES ARRAGON and YOSHINORI TOMODA: The oxidation of tetramethyl-α-*d*-methyltagatoside with nitric acid.

MLLE. DINAH BIQUARD: The Raman spectra of indanone.

CHARLES EMILE BRAZIER and LÉONIDE GÉNAUX: The earthquake of June 11, 1938. Results shown by the seismographs at the Parc Saint-Mawr Observatory.

MENGLI ENIKEFF: Researches on the subterranean waters of the interior delta of the Niger.

HENRI BRANDSTETTER and JEAN LAGRULA: Values of the magnetic inclination in the Sahara and the Sudan.

RENÉ SOUÈGES: The embryogeny of the Nyctaginaceæ. The development of the embryo in *Oxybaphus viscosus*.

MARC SIMONET and PIERRE DANSEREAU: Several tetraploid mutations of *Petunia* appearing after treatment with colchicine.

WALTER RIESE: The structure and function of the brain of the newly born bear.

FERNAND LE CHUITON, CHARLES MISTRAL and JEAN DUBREUIL: Attempts at the vaccination of the pig with the virus of swine fever after passage through the guinea pig. Rapid loss of virulence for the pig and also of the antigenic power against the original virus.

## Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ASSOCIATE PROFESSOR OF ENTOMOLOGY in the Punjab Agricultural Service—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (August 15).

LECTURER IN ELECTRICAL ENGINEERING in the County Technical College, Worksop—The Principal (August 15).

PRINCIPAL of the Hendon Technical Institute—The Secretary to the Education Committee, Education Offices, 10 Great George Street, Westminster, S.W.1 (August 27).

LECTURER IN METALLURGY in the University of Leeds—The Registrar (September 1).

PRINCIPAL of the Bridgwater Art and Technical Institute—The Chief Education Officer, County Hall, Taunton (September 3).

LECTURER IN PHYSIOLOGY in the Portsmouth Municipal College—The Registrar.

## Reports and other Publications

*(not included in the monthly Books Supplement)*

### Other Countries

Spisy vydávané Přírodovědeckou Fakultou, Masarykovy University. Čís. 248: O difusních potencialech, VI (On the Diffusion Potential, VI). Napsal V. Čupr. Pp. 15. Čís. 249: Trois notes sur les espaces abstraits (Tři poznámky o abstraktních prostorech). Par Bedřich Pospíšil. Pp. 9. Čís. 250: Morfologický vývoj těšínského podbeskydí (Morphologische Entwicklung des Teschener Hügellandes). Napsal Fr. Vításek. Pp. 18. Čís. 251: Processus lemurinicus. Von Dr. Karl Kahn. Pp. 23. Čís. 252: Akustická měření katodovým oscilografem (Akustische Messungen mit dem Kathodenoszillographen). Napsal J. Zahradníček. Pp. 10. Čís. 253: O pasivité chromu a ferrochromu v kyselých roztocích (Passivity of Chromium and Ferrochromium in Acid Solutions). Napsali V. Čupr a O. Lasák. Pp. 16. Čís. 254: O přemístění rovnostranného trojúhelníka v prostoru a speciální ploše osmého stupně vytvořené tímto pohybem (Sur le déplacement d'un triangle équilatéral dans l'espace et sur une surface spéciale d'ordre huitième). Napsal Miloslav Pelišek. Pp. 28. Čís. 255: Vliv přípravy kysličníku zinečnatého na jeho redukci vodíkem (On the Influence of Preparation of Zinc Oxide on its Reduction by Hydrogen). Napsal F. Schacherl. Pp. 13. Čís. 256: Sur les caractères des points dans les espaces topologiques (O charakterech bodů v topologických prostorech). Par Bedřich Pospíšil. Pp. 23. Čís. 257: Pohlavní dvojtvárnost larev a kukel pakomárů (Geschlechtsdimorphismus der chironomidenlarven und -Puppen). Napsal Jan Zavřel. Pp. 23. Čís. 258: i. Sur les espaces compacts (O kompaktních prostorech); ii. Sur les caractères des points dans les espaces $\mathfrak{L}$ (O charakterech bodů v $\mathfrak{L}$-prostorech). Par Eduard Čech et Bedřich Pospíšil. Pp. 14. (Brno: A. Píša.) [197

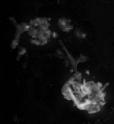
U.S. Department of Agriculture. Circular No. 478: The American Dog Tick, Eastern Carrier of Rocky Mountain Spotted Fever. By F. C. Bishopp and Carroll N. Smith. Pp. 26. 5 cents. Farmers' Bulletin No. 1798: Control of Common White Grubs in Cereal and Forage Crops. By Philip Luginbill. Pp. 20. 5 cents. Technical Bulletin No. 599: Biology of the Pea Weevil in the Pacific Northwest with Suggestions for its Control on Seed Peas. By A. O. Larson, T. A. Brindley and F. G. Hinman. Pp. 48. 10 cents. (Washington, D.C.: Government Printing Office.) [207

Mexico's Resources for Livelihood: a Study of the Influence of Foreign Ownership. By Alejandra Carrillo. Pp. 34. 25 cents. Gold and Poverty in South Africa: a Study of Economic Organization and Standards of Living. By Max Yergan. Pp. 24. 15 cents. (The Hague and New York: International Industrial Relations Institute.) [217

Briefe Franz Xaver Freiherrn von Zach und seines Nachfolgers Bernhards von Lindenau von 1791–1816 an P. Martin Alois David. Herausgegeben von Otto Seydl. (Publikace Pražské Státní Hvězdárny, Č. 11.) Pp. 206. (Praha: Státní Hvězdárna Republiky Československé.) [246

Lucknow University Studies. No. 10: The General Field Theory of Schouten and Van Dantzig. By Prof. N. G. Shabde. Pp. iv+58. (Lucknow: Lucknow University.) [17

Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen. Afdeeling Natuurkunde, Sectie 1, Deel 16, No. 4: Second Report on Viscosity and Plasticity. Prepared by the Committee for the Study of Viscosity of the Academy of Sciences at Amsterdam. Pp. viii+287+2 plates. (Amsterdam: N.V. Noord-Hollandsche Uitgeversmaatschappij.) [17

Festschrift zum 60 Geburtstage von Prof. Dr. Embrik Strand: enthaltend dem Jubilar gewidmete Arbeiten ausländischer Zoologen und Paläontologen. Vol. 1. Pp. ii+644+14 plates. Vol. 2. Pp. ii+652+37 plates. Vol. 3. Pp. ii+608+20 plates. Vol. 4. Pp. ii+784+16 plates. (Riga: Sistematiskas Zoologijas Instituts.) [17

U.S. Department of Agriculture. Circular No. 474: Muskrat Investigations in Dorchester County, Md., 1930–34. By Frank B. Smith. Pp. 24. 10 cents. Leaflet No. 161: The Eastern Tent Caterpillar. By F. M. Wadley. Pp. 4. 5 cents. Technical Bulletin No. 601: Selenium Occurrence in Certain Soils in the United States with a Discussion of Related Topics; Third Report. By Horace G. Byers, John T. Miller and K. T. Williams, and H. W. Lakin. Pp. 75. 15 cents. Technical Bulletin No. 607: Occurrence of the Beet Leafhopper and Associated Insects on Secondary Plant Successions in Southern Idaho. By D. E. Fox. Pp. 44. 10 cents. (Washington, D.C.: Government Printing Office.) [247